ANTI-FRICTION LINESHAFT BEARINGS

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A STUDY OF

ANTI-FRICTION LINESHAFT BEARINGS

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H M Raymond

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INTRODUCTION

The object of this test is the determination of the coefficient of friction and the horse power necessary to drive various types of line shafting bearings. Much research work has been done along these lines, but, no information is available which compares in a logical manner babbitt, roller and ball bearings.

In conducting these tests, the three types of bearings were operated at various loads and speeds varying from maximum to minimum. The power input was determined by means of a carefully calibrated reaction dynamometer and the coefficient of friction was calculated from the resulting data.

The bearings tested were: one ball, three roller and one babbitt. The method of procedure for one bearing was exactly the same for another. In each case the amount and kind of lubricant called for by the manufacturers of the bearings

was used. Before mounting a set of bearings on the shaft each one was thoroughly cleaned and the lubricant replaced.

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ARRANGEMENT OF APPARATUS

AND

METHOD OF TESTING

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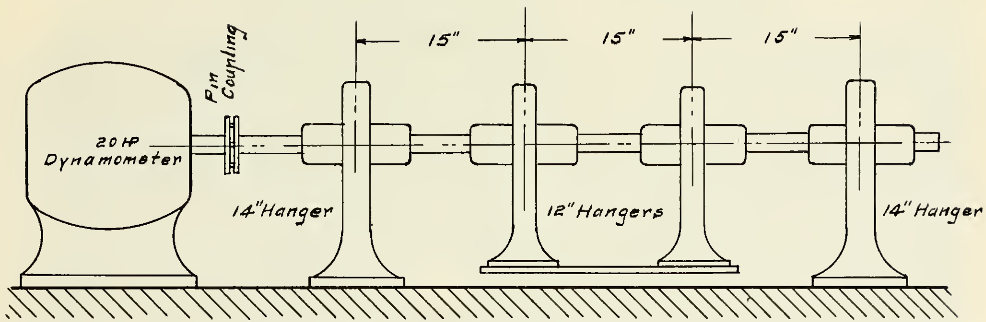

15"
15"
15"
Pin Coupling
20 HP Dynamometer
14" Hanger
12" Hangers
14" Hanger

Fig. 2

ARRANGEMENT OF APPARATUS AND METHOD OF TESTING.

Two of the bearings were mounted in 14 inch hangers, and these hangers were bolted to a surfaced steel table and placed 45 inches from each other. The other two bearings were mounted in 12 inch hangers and spaced 15 inches center to center and midway between the first two hangers.(Fig.1)

A plate was bolted on the bottoms of the two middle hangers and served as a platform to receive the dead weight. The two central hangers were two inches shorter than the two outside hangers, thereby allowing the central unit to swing freely about the shaft.

The shaft was coupled to the 20 H.P. dynamometer. Two collars were placed on one of the center bearings and two on one of the end bearings to prevent end thrust travel.

All bearings were taken from the stock

intended for sale and were new. All sets were operated until the friction became constant. After these preliminary runs, the apparatus was allowed to stand over night so as to insure uniform temperature conditions for each set of tests.

The load was placed in carriers hung upon a stationary beam which rested on the plate suppoted by the two center hangers. The friction load was transmitted through the agency of the dynamometer arm to a sensitive scale.

The first load applied was 3000 pounds or 1500 pounds per bearing, and the speed of the shaft was the maximum which the bearing could stand. The speed was obtained by an electric speed counter and checked by a hand revolution counter. The load on the scale was read at the same time. The speed was then lowered a few hundred R.P.M. and the load on scale again read. This process was repeated until the shaft was going as slowly as the motor

would turn it. Then the load was reduced from 3000 to 2700 and the entire process repeated; about twelve readings being taken for each load from 1500 down to 300 in increments of 150 pounds. The load of 300 was the minimum since this represented the actual weight of the hangers, bearings, shaft and plate.

This completed the run for a set of bearings, but, in order to verify the results the shaft and bearings were allowed to cool off until the next morning and the test repeated.

GENERAL THEORY

GENERAL THEORY

The load on the two center bearings consisted of, the weights of the two center bearings, the two center hangers, the cast iron plate and the added dead weight. The total load on the two end bearings was the above weight plus the weight of the shaft and coupling. The average load per bearing was, therefore, one-half of the weight of the two center bearings, the cast iron plate, the shaft and coupling, and the added weights. This is the load recorded in the tables, and ranges from 1500 pounds maximum to 300 pounds minimum.

All readings were taken simultaneously. The dynamometer was tested for balance before each new set of runs, thus insuring accuracy.

The torque was obtained by multiplying the force on the scale by the lever arm of the dynamometer, in our case $31\frac{1}{2}$ inches. This torque was in inch pounds, and repre-

sented the torque necessary to drive the four bearings and one-fourth of this was the torque necessary to drive one bearing.

The H. P. necessary to drive one bearing at any load and speed, was computed from the torque and speed by accepted methods:

$$\text{H.P.} = \frac{\text{Lbs. \& R.P.M.}}{2000}$$

The 2000 is the constant of this dynamometer.

The coefficient of friction was computed from the load and the torque. It is readily seen that the torque at the shaft is equal to the ratio of the lever arm of the dynamometer to the lever arm of the shaft, the radius, times the torque at the dynamometer arm, as follows:--

$$\text{No. Lbs. torque} \times \frac{31.5''}{1\text{-}\frac{7''}{32}} = \text{torque at shaft.}$$

The coefficient of friction is the torque at the shaft divided by the load.

$$\text{Coefficient of friction} = \text{K.} = \frac{\text{torque at shaft}}{\text{load}}$$

The coefficient of friction was computed in two ways. In the first method, as outlined on page 12, designated in the tables as "A", the actual radius of the shaft was used. In the second method, the radius of the ball or roller line circumference was used.

It is a difficult matter to decide which is the proper way to figure the coefficient. It can be seen from the formula for the coefficient of friction that the ball and roller bearings assume a decided advantage over the babbitt bearing by the use of method "B", inasmuch as the friction radius is increased by taking it as the distance from center of ball or roller to the center of shaft, and an increase in the friction radius decreases the coefficient of friction.

In most of the testing done to date, the coefficient of friction was usually figured by method "B", but, it is the opinion of the writers that it is unfair to the babbitt bearings and for that reason, a preference

has been given to method "A". In a ball or roller bearing, the friction really acts at the tracks on which the balls or rolls turn, but, for purposes of comparison with plain bearings, the friction is referred to the bearing bore, which is identical with the shaft diameter.

It is understood that a comparison of the coefficient of friction of bearings is necessary, but, at the same time, it should be understood that the coefficient of friction influences, not so much the amount of power to drive the shafting, as it influences the bearing itself. A high coefficient will shorten the life of the bearing, because a great quantity of rubbing and lashing will occur which will injure the bearing constituents. This will be used up energy changed to the form of heat, and it will ultimately cause an increase in the power necessary to drive. But, if an anti-friction bearing be properly designed, there is little danger of an excessive coefficient of friction and the usual

loss of power through heating.

For this reason, the truest comparison of bearings is to compare the horse power necessary to drive, and that the best bearing, is, the one which will run cold at any ordinary speed and load and require the least amount of power.

An important point in economic power transmission is lubrication. The manufacturers of babbitt bearings all recommend the use of machine oil, and in some instances, they have made tests to find out which oil was best suited to their bearing and how often and how much was required. But, when the anti-friction bearings came into use, the manufacturers maintained that ball and roller bearings should survive in the absence of lubrication, but, they now recommend the use of a lubricant, because, foreign matter in the raceways cannot be eliminated in any other way.

This does not necessarily mean that lubrication increases the efficiency of a

properly designed ball or roller bearing, for the reverse is true, as has been illustrated by experiments. They will give a lower coefficient of friction when running clean and dry than when lubricated by even a thin oil.

In perfectly lubricated journal bearings, there is no metallic contact between surfaces, but, in the ball and roller bearings, there is always metallic contact.

The coefficient of friction for sliding contact is much higher than for rolling contact. The coefficient of rest and slow motion is much greater for sliding friction than for rolling.

CLASSIFICATION OF BEARINGS TESTED

CLASSIFICATION OF BEARINGS TESTED

For all convenience in this work, each type of bearing tested is to be referred to by initial, as follows:--

BEARING

"A"......DUPLEX TAPER ROLLER.

"B"......HELICAL ROLLER.

"C"......BABBITTED RING OILED.

"D"......DOUBLE ROW SELF ALIGNING BALL BEARING.

"E"......CYLINDRICAL PLAIN ROLLER.

BEARING "A"

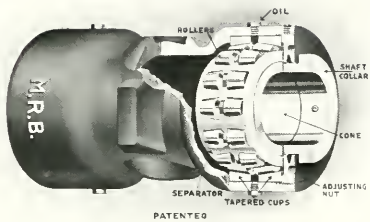
OIL
ROLLERS
SHAFT
COLLAR
M.R.B.
CONE
ADJUSTING
NUT
SEPARATOR
TAPERED CUPS
PATENTED

Fig. 3

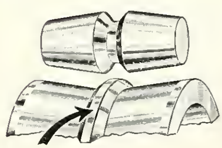

Fig. 4

Fig. 5

BEARING "A"

Bearing "A" (Figures 3,4,5) is a duplex roller bearing having as its chief feature, two sets of double tapered rollers. The housing of cast iron has a diameter sufficient to contain one set of rolls in each end.

A hardened steel cone fits on the shaft and revolves with it. The double tapered rolls run on this cone and are held central by means of a projection in the center of the cone which fits into the groove of the rolls. (Fig.4) The rolls are kept at a constant distance from each other by means of a bronze separator.

On the top of the rolls are two tapered cups arranged so that one is on the one taper of the roll and one on the other. These two tapered cups act as the upper raceway for the rolls.

The whole set fits inside one end of the housing, the end of which is threaded to accomodate a nut which when screwed in tightens

or loosens the tapered cups against the rolls. A set screw from the housing and onto the adjustment is tightened when the bearing is adjusted. Oil may be poured in through a hole in the top of the housing.

Bearing "A" being of the double taper type has in addition to the slipage due to misalignment and the slipage due to an area of contact instead of line contact, the slipage due to the double taper. This results from the fact that one laminae of the roll is revolving at a slightly greater or less speed than the next one due to its greater or less diameter, thus causing a slipage. But, the loss of power or increase in coefficient due to this, is negligible in comparison to the loss due to misalignment and irregularity of surface. For that reason, the firm manufacturing that bearing claims that after the bearing has been run in for two or three months, it runs at a greater efficiency due to the polish of the

surfaces and grinding out of the rough spots on the separator.

A good feature of Bearing "A", is, that it showed very little tendency toward the introduction of end thrust. The fact, that the collars which go with this bearing fit so that they revolve on the shaft and at the same speed as the bearing sleeve, eliminates any friction due to end thrust which is a most desirable feature.

The bearing did not heat up to any extend, except on such loads and speeds which very seldom are used for line shafting work. As can be seen by the data sheets and curves, this bearing was run at higher speed than any of the others. At the high speeds and loads, the grease ran hot, but, as a whole, the bearing ran remarkably cool.

Another good feature about this bearing is, its adaptability to adjustment.

TABLES 1 - 16

of

BEARING "A"

BEARING A

Table No. 1 Date July 2nd, 1915.

Bearing Load, LBS. 1500 Time, beginning of run 8:20 A.M.

Room Temp.° Fahr. 75 Time, end of run 8:44 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.55	1619	17.42	0.445	0.0095	0.0062
0.54	1513	17.00	0.408	0.0093	0.0061
0.535	1368	16.88	0.366	0.0092	0.0060
0.52	1148	16.40	0.298	0.0090	0.0058
0.505	876	15.91	0.219	0.0087	0.0056
0.52	806	16.40	0.208	0.0090	0.0058
0.525	679	16.57	0.178	0.0091	0.0059
0.535	611	16.88	0.163	0.0092	0.0060
0.55	501	17.42	0.138	0.0095	0.0062
0.57	372	17.98	0.106	0.0098	0.0064
0.62	212	19.56	0.066	0.0107	0.0069

Remarks:—

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BEARING A

Table No. 2 Date July 2nd, 1915.

Bearing Load, LBS. 1350 Time, beginning of run 8:44 A.M.

Room Temp.° Fahr. 75 Time, end of run 9:06 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.50	1743	15.75	0.436	0.0096	0.0062
0.485	1622	15.27	0.393	0.0093	0.0061
0.48	1446	15.11	0.347	0.0092	0.0060
0.47	1273	14.80	0.299	0.0090	0.0058
0.46	971	14.48	0.223	0.0088	0.0057
0.48	836	15.11	0.201	0.0092	0.0060
0.485	725	15.27	0.176	0.0093	0.0061
0.49	646	15.41	0.158	0.0094	0.0061
0.51	481	16.07	0.122	0.0098	0.0061
0.55	305	17.31	0.084	0.0105	0.0068
0.58	189	18.89	0.057	0.0115	0.0075

Remarks:—

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BEARING A

Table No. 3 Date July 2,1915.

Bearing Load, LBS. 1200 Time, beginning of run 9:06 A.M.

Room Temp.° Fahr. 75 Time, end of run 9:23 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.46	1863	14.50	0.429	0.0099	0.0064
0.445	1714	14.02	0.382	0.0096	0.0062
0.425	1502	13.36	0.319	0.0091	0.0059
0.405	1216	12.75	0.246	0.0087	0.0056
0.40	1002	12.60	0.200	0.0086	0.0056
0.405	878	12.75	0.178	0.0087	0.0056
0.405	781	12.75	0.158	0.0087	0.0056
0.405	709	12.75	0.144	0.0087	0.0056
0.415	566	13.06	0.118	0.0089	0.0058
0.48	286	15.12	0.069	0.0103	0.0067
0.52	181	16.38	0.047	0.0112	0.0073

Remarks:—

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BEARING A

Table No. 4 Date July 2nd, 1915.

Bearing Load, LBS. 1050 Time, beginning of run 9:23 A.M.

Room Temp.° Fahr. 75 Time, end of run 9:45 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31¼ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.47	1956	14.78	0.460	0.0116	0.0075
0.43	1836	13.52	0.395	0.0106	0.0069
0.405	1715	12.75	0.347	0.0100	0.0065
0.39	1530	12.28	0.298	0.0096	0.0062
0.385	1241	12.10	0.239	0.0095	0.0062
0.325	919	11.80	0.172	0.0092	0.0060
0.365	810	11.48	0.148	0.0090	0.0058
0.365	688	11.48	0.126	0.0090	0.0058
0.375	510	11.80	0.096	0.0092	0.0060
0.425	269	13.38	0.057	0.0105	0.0068
0.475	170	14.92	0.046	0.0117	0.0076

Remarks:—

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BEARING A

Table No. 5 Date July 2nd,1915.

Bearing Load, LBS. 900 Time, beginning of run 9:45 A.M.

Room Temp.° Fahr. 75 Time, end of run 10:10 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.435	2065	13.70	0.453	0.0125	0.0081
0.39	1826	12.28	0.356	0.0112	0.0073
0.34	1687	10.70	0.287	0.0098	0.0064
0.33	1469	10.40	0.242	0.0095	0.0062
0.325	1279	10.23	0.208	0.0094	0.0061
0.32	948	10.08	0.152	0.0092	0.0060
0.32	841	10.08	0.135	0.0092	0.0060
0.315	715	9.93	0.113	0.0091	0.0059
0.32	490	10.08	0.079	0.0092	0.0060
0.37	242	10.64	0.045	0.0097	0.0063
0.40	166	12.60	0.033	0.0115	0.0075

Remarks:—

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BEARING A

Table No. 6 Date July 2nd, 1915.

Bearing Load, LBS. 750 Time, beginning of run 10:10 A.M.

Room Temp.° Fahr. 75 Time, end of run 10:30 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.35	2205	11.02	0.386	0.0121	0.0079
0.325	2072	10.23	0.336	0.0112	0.0073
0.30	1834	9.46	0.275	0.0104	0.0067
0.28	1481	8.82	0.208	0.0097	0.0063
0.28	1308	8.82	0.183	0.0097	0.0063
0.27	1096	8.51	0.148	0.0093	0.0060
0.27	914	8.51	0.123	0.0093	0.0060
0.27	827	8.51	0.112	0.0093	0.0060
0.27	760	8.51	0.103	0.0093	0.0060
0.27	560	8.51	0.076	0.0093	0.0060
0.28	334	8.82	0.047	0.0097	0.0063
0.33	202	10.40	0.033	0.0114	0.0074

Remarks:—

BEARING A

Table No. 7 Date July 2nd, 1915.

Bearing Load, LBS. 600 Time, beginning of run 10:30 A.M.

Room Temp.° Fahr. 75 Time, end of run 10:45 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.33	2316	10.40	0.382	0.0142	0.0092
0.31	1944	9.78	0.302	0.0134	0.0087
0.28	1626	8.82	0.228	0.0121	0.0078
0.26	1329	8.19	0.173	0.0112	0.0073
0.25	1077	7.88	0.135	0.0108	0.0070
0.23	972	7.25	0.112	0.0099	0.0064
0.21	856	6.61	0.090	0.0091	0.0059
0.20	653	6.30	0.065	0.0086	0.0056
0.255	221	8.04	0.028	0.0110	0.0071
0.275	148	8.67	0.020	0.0119	0.0077

Remarks:—

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

BEARING A

Table No. 8 Date July 2nd, 1915.

Bearing Load, LBS. 450 Time, beginning of run 10:45 A.M.

Room Temp.° Fahr. 75 Time, end of run

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.29	2349	9.14	0.342	0.0167	0.0108
0.25	1986	7.88	0.248	0.0144	0.0093
0.23	1736	7.25	0.200	0.0132	0.0086
0.215	1439	6.78	0.155	0.0124	0.0080
0.20	1112	6.30	0.111	0.0115	0.0075
0.19	970	5.99	0.092	0.0109	0.0071
0.19	800	5.99	0.076	0.0109	0.0071
0.185	603	5.83	0.056	0.0106	0.0069
0.195	384	6.15	0.037	0.0112	0.0073
	206	10.08	0.033	0.0184	0.0119

Remarks:—

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

BEARING A

Table No. 9 Date July 2nd, 1915.

Bearing Load, LBS. 300 Time, beginning of run

Room Temp.° Fahr. 75 Time, end of run 11:15 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.22	2577	6.93	0.283	0.0189	0.0123
0.185	2174	5.83	0.201	0.0159	0.0103
0.165	1743	5.20	0.144	0.0142	0.0092
0.135	1388	4.25	0.094	0.0116	0.0075
0.105	988	3.31	0.052	0.0091	0.0059
0.09	886	2.83	0.040	0.0078	0.0051
0.085	818	2.68	0.035	0.0073	0.0047
0.08	591	2.52	0.024	0.0069	0.0045
0.105	235	3.31	0.012	0.0091	0.0059
0.13	139	4.09	0.009	0.0112	0.0073

Remarks:—

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

DATA INTERPOLATED FROM TABLES 1—9

Bearing A

R. P. M. of Shaft 2000

Table No. 10

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500			
1350			
1200			
1050			
900	0.400	0.012	0.0080
750	0.315	0.0115	0.0075
600	0.315	0.0130	0.0085
450	0.255	0.0150	0.0097
300	0.175	0.0150	0.0097

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing A

R. P. M. of Shaft 1600

Table No. 11

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.435	0.0095	0.0062
1350	0.390	0.0092	0.0060
1200	0.345	0.0095	0.0060
1050	0.316	0.0097	0.0062
900	0.265	0.010	0.0068
750	0.230	0.0105	0.0065
600	0.230	0.015	0.0075
450	0.180	0.0134	0.0085
300	0.125	0.0125	0.0080

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing A

R. P. M. of Shaft 1200

Table No. 12

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.315	0.0088	0.0055
1350	0.280	0.0090	0.0058
1200	0.245	0.0090	0.0058
1050	0.225	0.0095	0.0060
900	0.190	0.0093	0.0058
750	0.162	0.0096	0.0060
600	0.151	0.0098	0.0065
450	0.120	0.012	0.0070
300	0.070	0.0097	0.0060

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing A

R. P. M. of Shaft 800

Table No. 13

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.21	0.0088	0.0055
1350	0.190	0.0095	0.0060
1200	0.165	0.0085	0.0055
1050	0.152	0.0092	0.0060
900	0.128	0.0090	0.0055
750	0.110	0.0092	0.0058
600	0.090	0.009	0.0059
450	0.075	0.0105	0.0065
300	0.038	0.0075	0.005

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing A

R. P. M. of Shaft 600

Table No. 14

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
1500	0.164	0.009	0.0064
1350	0.150	0.010	0.0068
1200	0.125	0.009	0.0055
1050	0.115	0.009	0.0060
900	0.10	0.009	0.0055
750	0.085	0.0092	0.0060
600	0.065	0.0090	0.0058
450	0.056	0.0107	0.0065
300	0.025	0.0071	0.0048

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing A

R. P. M. of Shaft 400

Table No. 15

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.115	0.0095	0.0063
1350	0.105	0.010	0.0068
1200	0.085	0.0098	0.0064
1050	0.080	0.0096	0.0063
900	0.068	0.0095	0.0060
750	0.057	0.0098	0.0063
600	0.045	0.0098	0.0060
450	0.042	0.013	0.0078
300	0.015	0.0077	0.0052

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing A

R. P. M. of Shaft 200

Table No. 16

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.063	0.01	0.007
1350	0.062	0.011	0.0075
1200	0.045	0.011	0.0075
1050	0.042	0.0115	0.0075
900	0.038	0.0110	0.0073
750	0.035	0.0114	0.0075
600	0.025	0.0113	0.0070
450	0.032	0.0185	0.012
300	0.010	0.010	0.0065

Remarks:—

- -

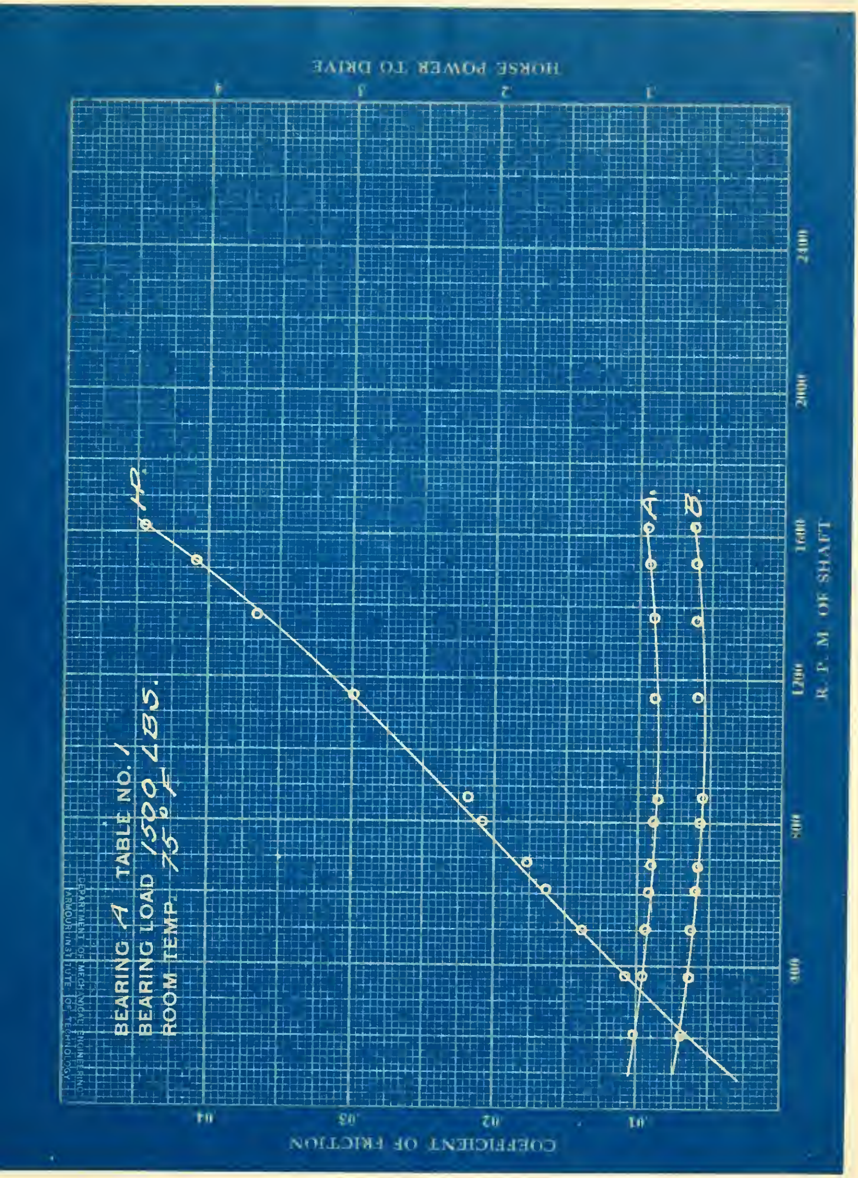
CURVES PLOTTED FROM

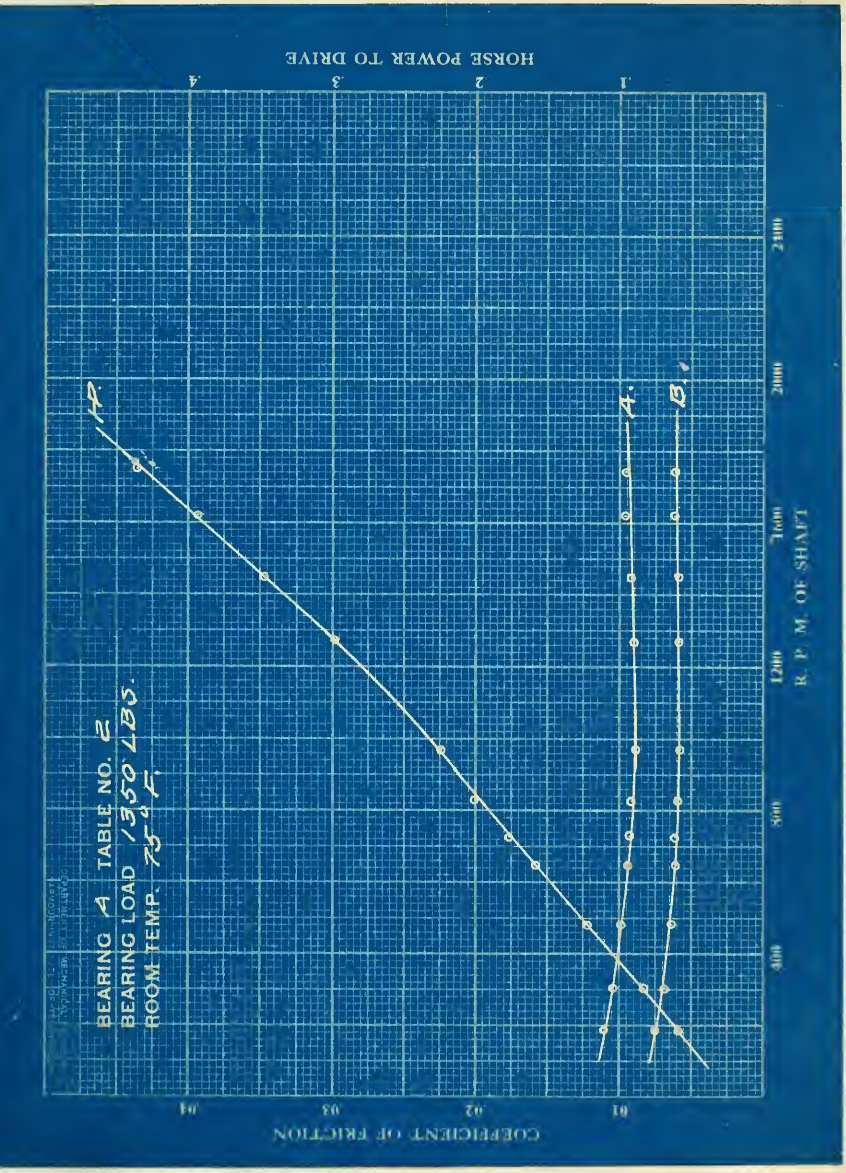
TABLES 1 - 16

OF

BEARING "A"

- -


BEARING A TABLE NO. 1
BEARING LOAD 1500 LBS.
ROOM TEMP. 75° F
DEPARTMENT OF MECHANICAL ENGINEERING
ARMOUR INSTITUTE OF TECHNOLOGY
HORSE POWER TO DRIVE
1
2
3
4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
H.P.
A.
B.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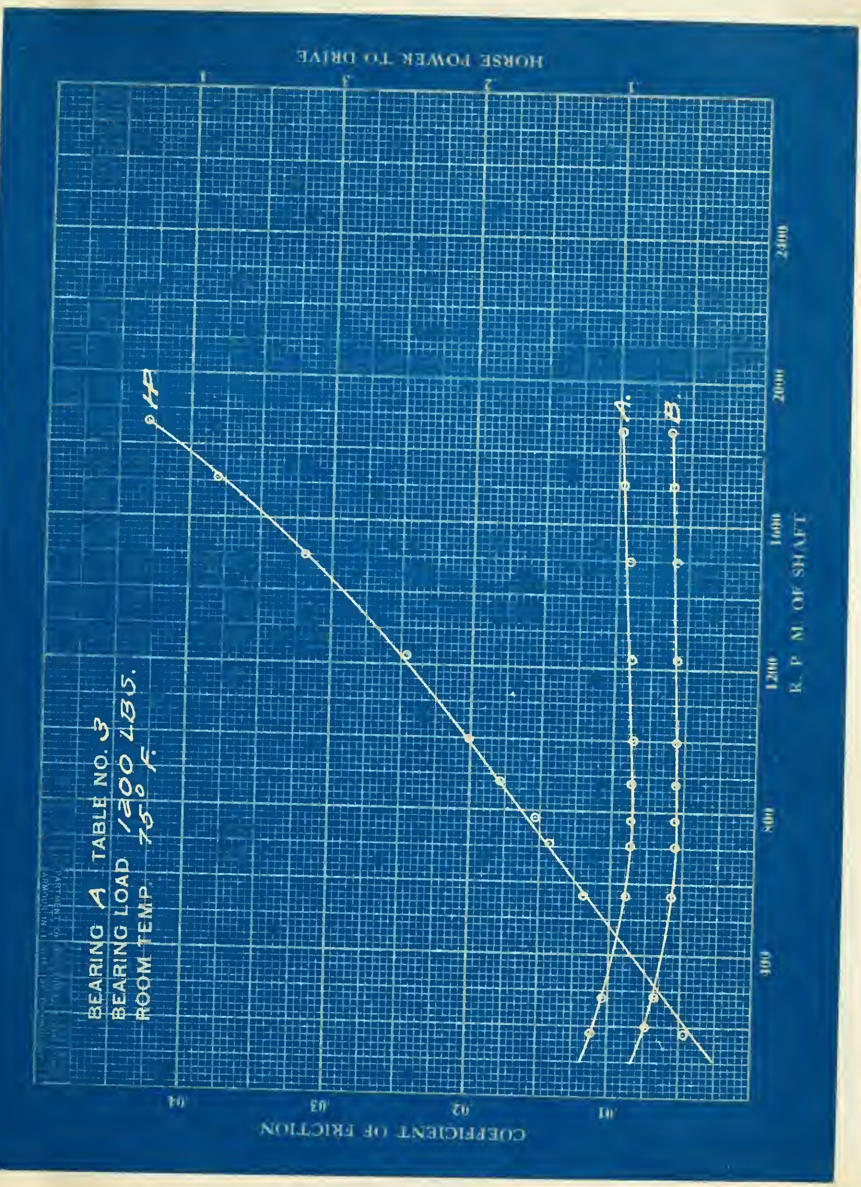
BEARING LOAD 1350 LBS.
ROOM TEMP. 75° F.
H.P.
A.
B.
HORSE POWER TO DRIVE
R. P. M. OF SHAFT
COEFFICIENT OF FRICTION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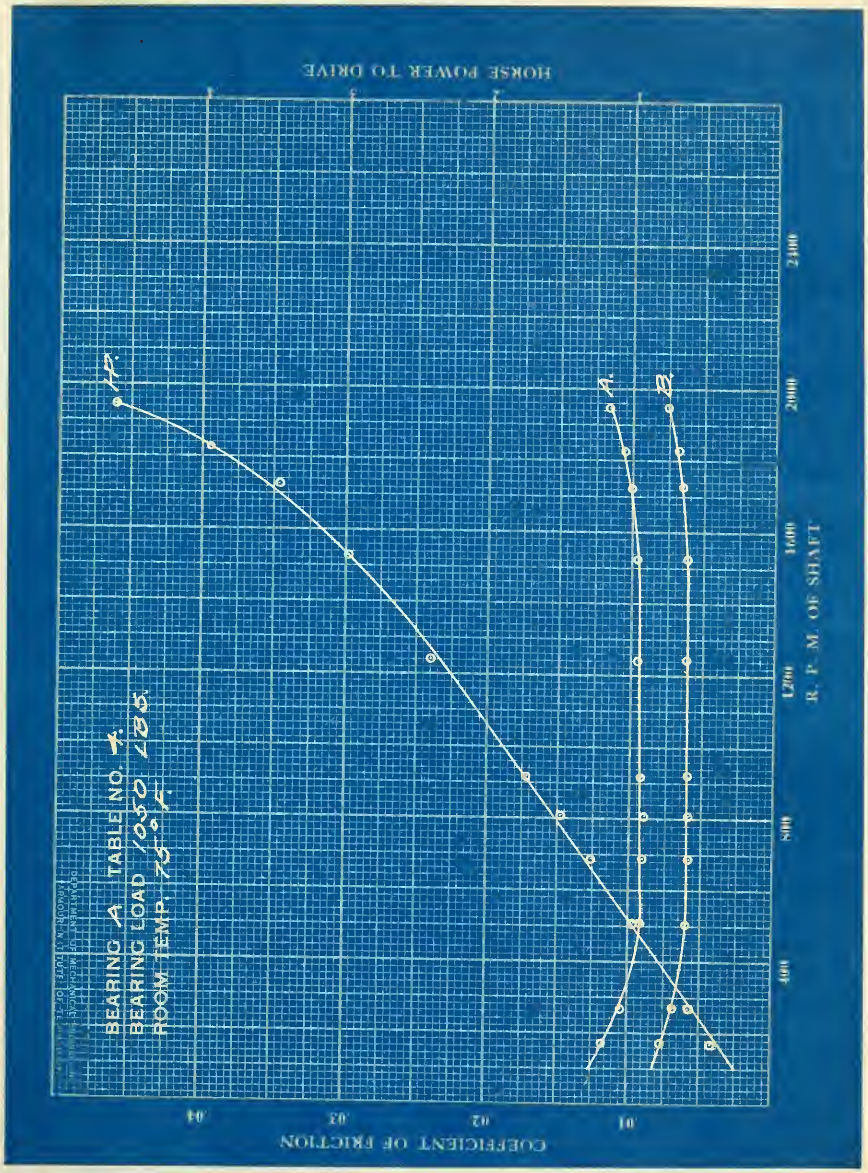
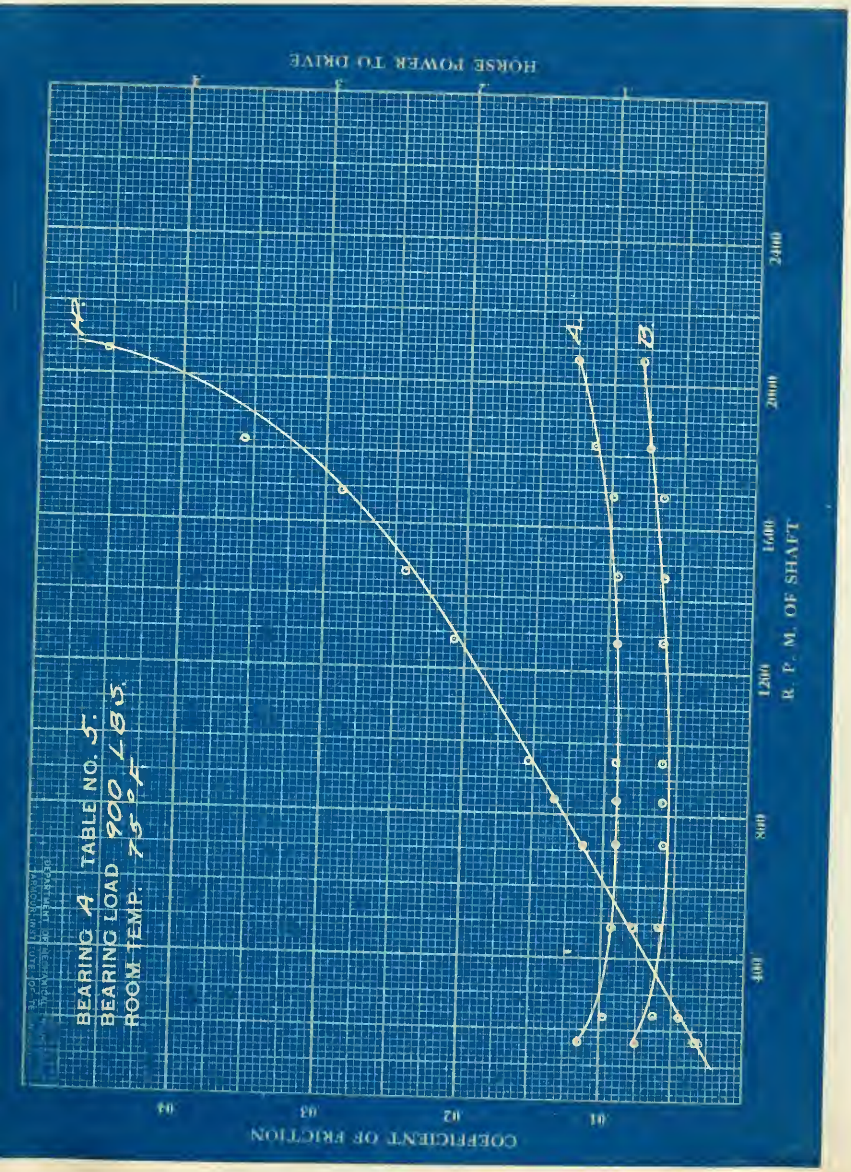
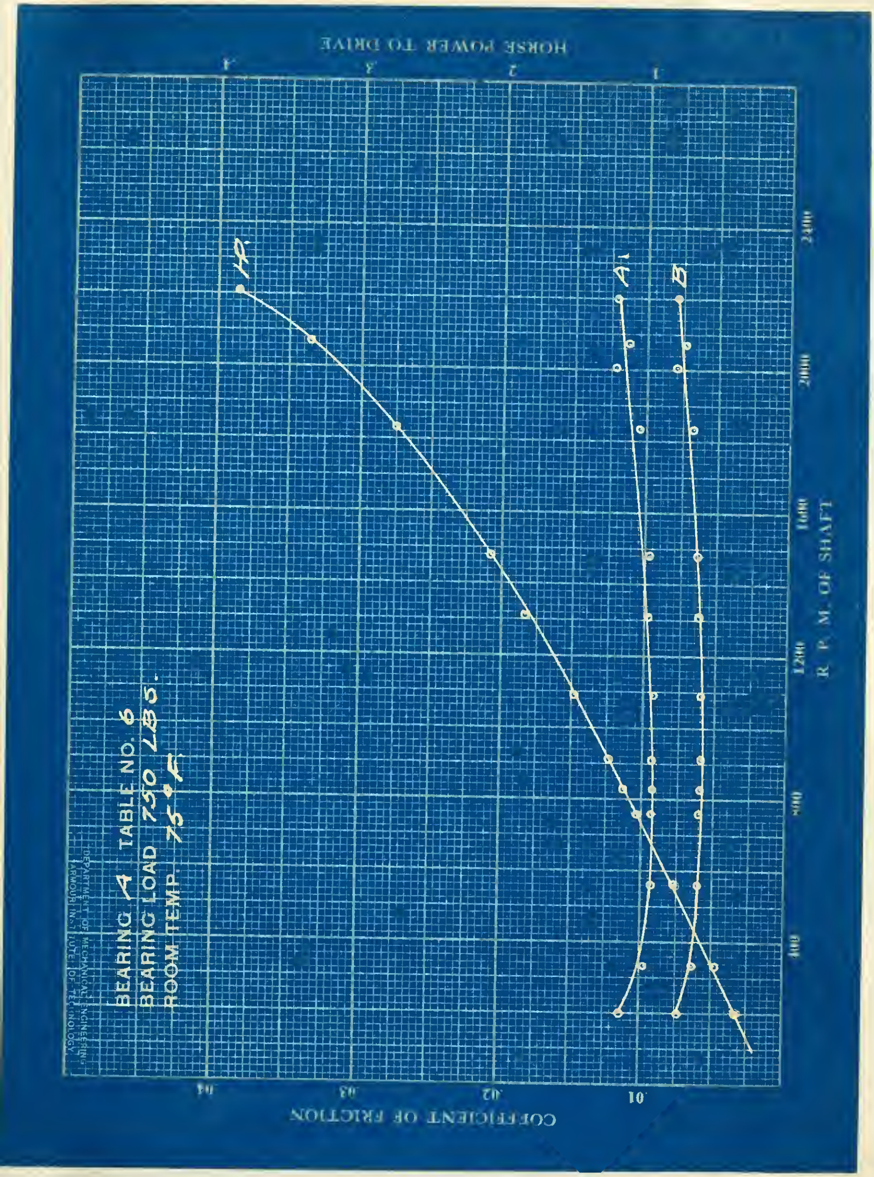
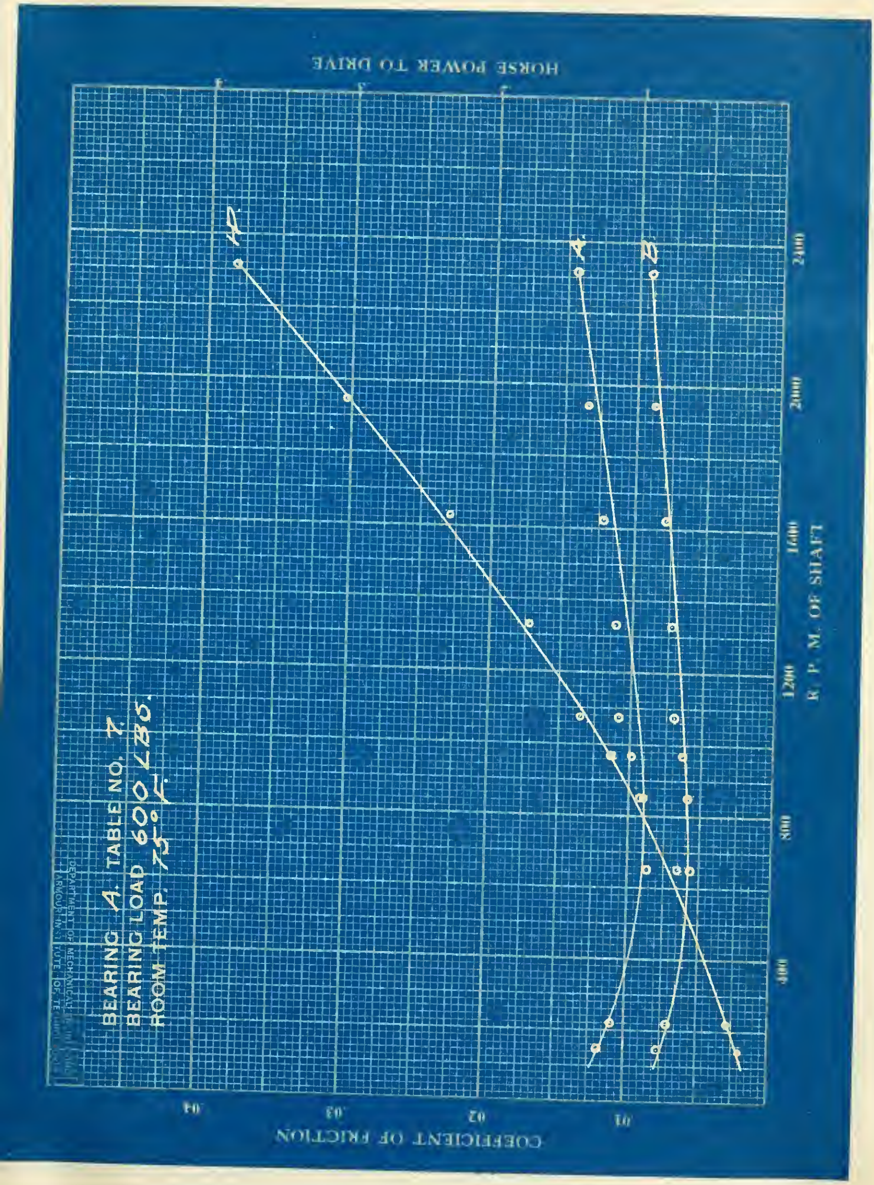
BEARING LOAD 1200 LBS.
ROOM TEMP. 75° F.
HORSE POWER TO DRIVE
R. P. M. OF SHAFT
COEFFICIENT OF FRICTION
.01
.02
.03
.04
.1
.2
.3
400
800
1200
1600
2000
2400
H
A.
B.


HORSE POWER TO DRIVE
COEFFICIENT OF FRICTION
R. P. M. OF SHAFT
BEARING A TABLE NO. 7.
BEARING LOAD 1050 LBS.
ROOM TEMP. 75° F.
H.P.
A.
B.
400
800
1200
1600
2000
2400
.01
.02
.03
.04

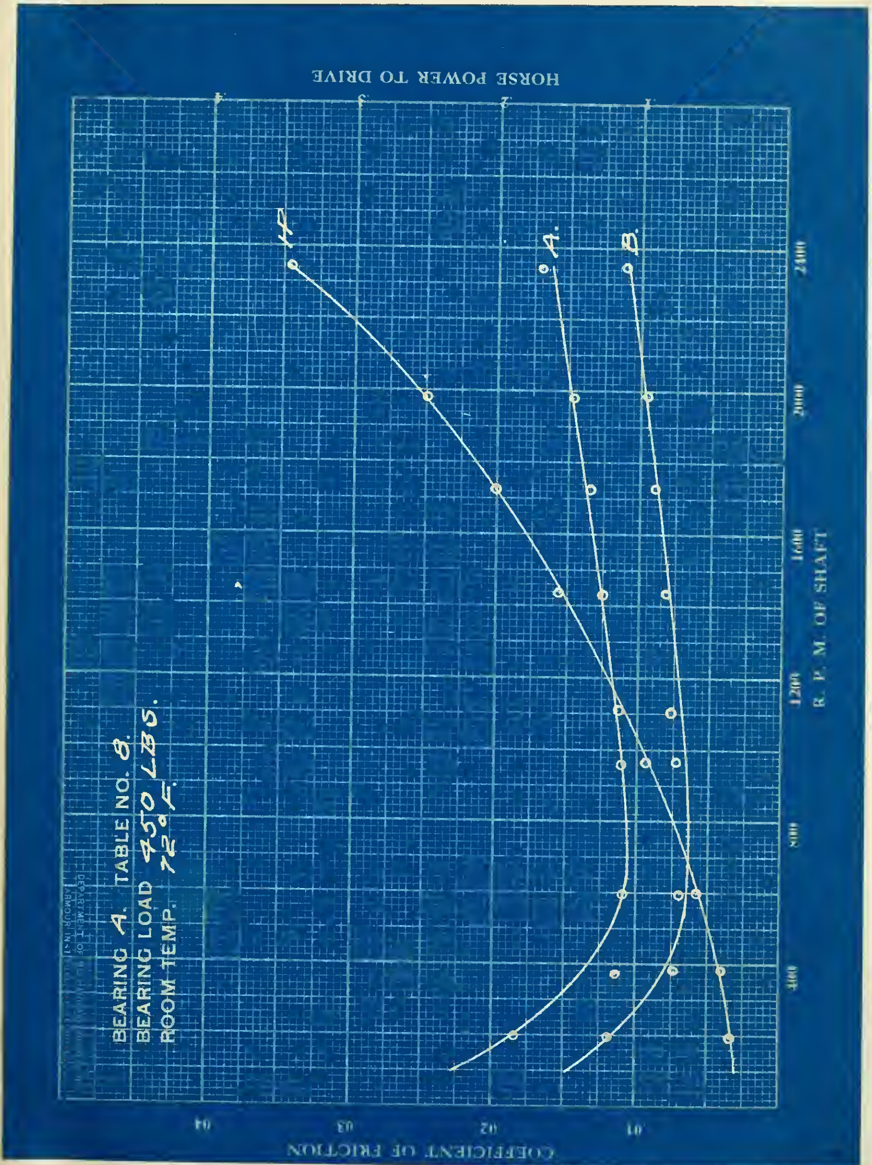


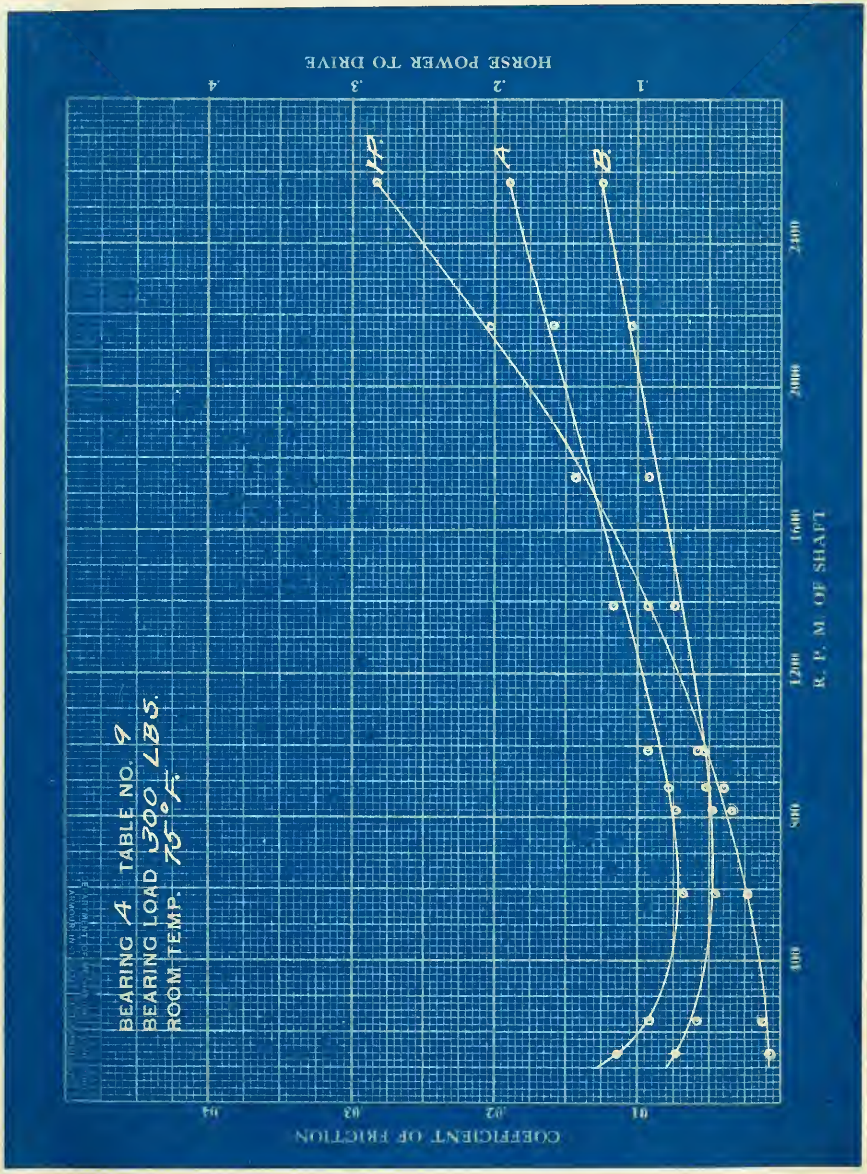
BEARING A TABLE NO. 5.
BEARING LOAD 900 LBS.
ROOM TEMP. 75°F
HORSE POWER TO DRIVE
COEFFICIENT OF FRICTION
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
.01
.02
.03
.04
HP
A
B


HORSE POWER TO DRIVE
COEFFICIENT OF FRICTION
R. P. M. OF SHAFT
BEARING A TABLE NO. 6
BEARING LOAD 750 LBS.
ROOM TEMP. 75°F
DEPARTMENT OF MECHANICAL ENGINEERING
ARMOUR INSTITUTE OF TECHNOLOGY
HP
A
B

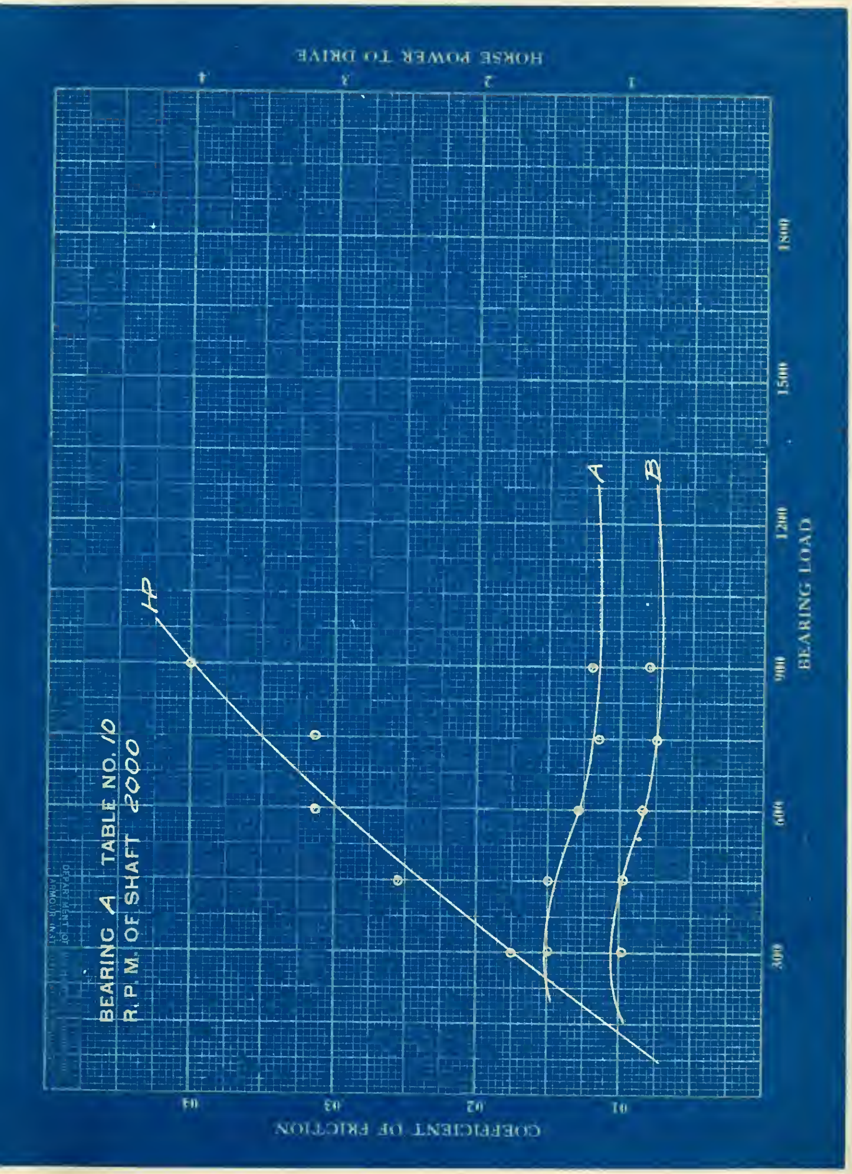


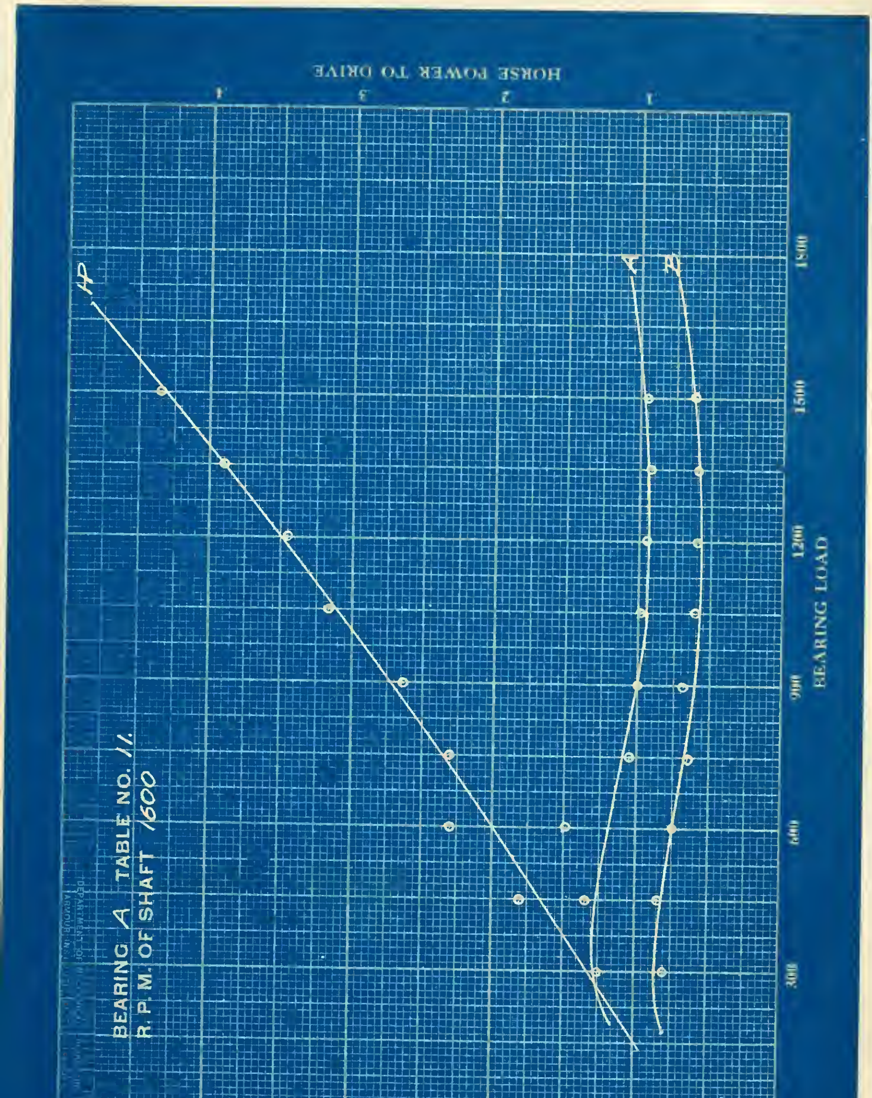
BEARING A. TABLE NO. 7.
BEARING LOAD 600 LBS.
ROOM TEMP. 75°F.
HORSE POWER TO DRIVE
COEFFICIENT OF FRICTION
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
.01
.02
.03
.04
A
B
HP.

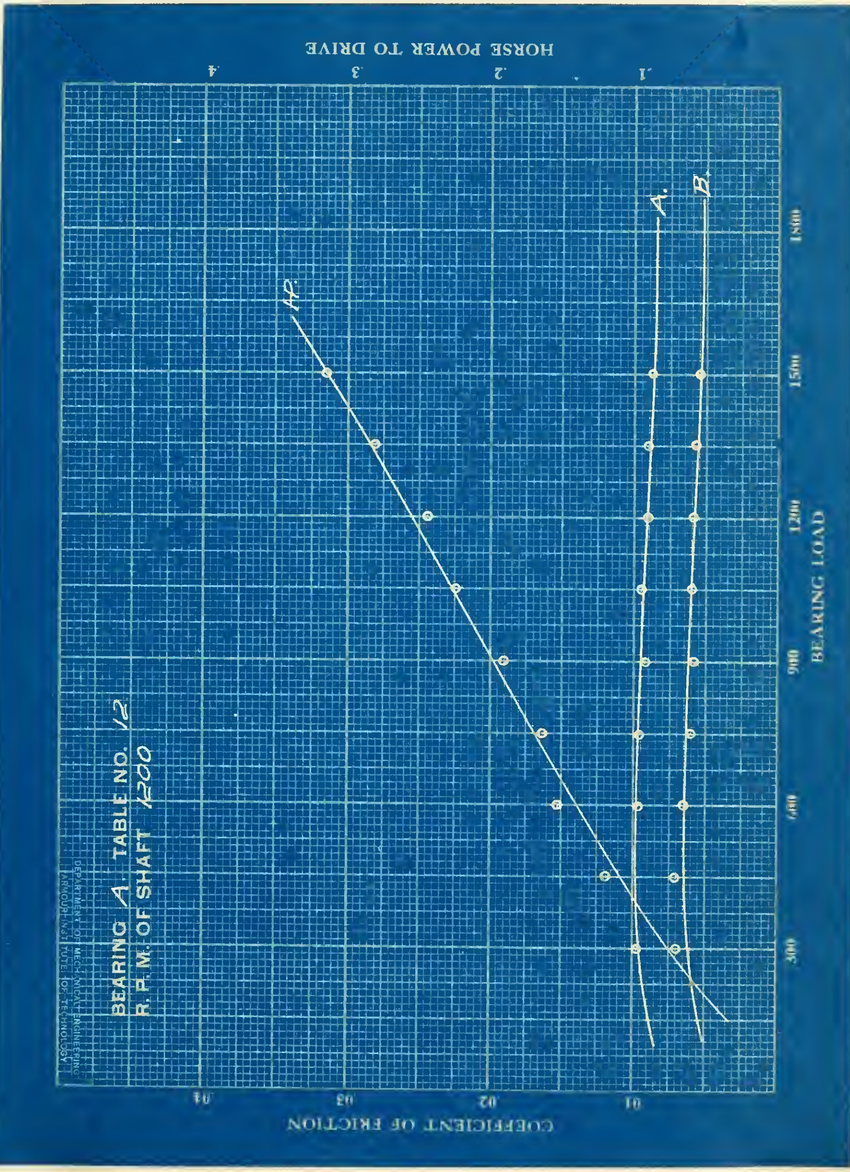

BEARING A. TABLE NO. 8.
BEARING LOAD 450 LBS.
ROOM TEMP. 72°F.
HORSE POWER TO DRIVE
1
2
3
4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
H
A.
B.

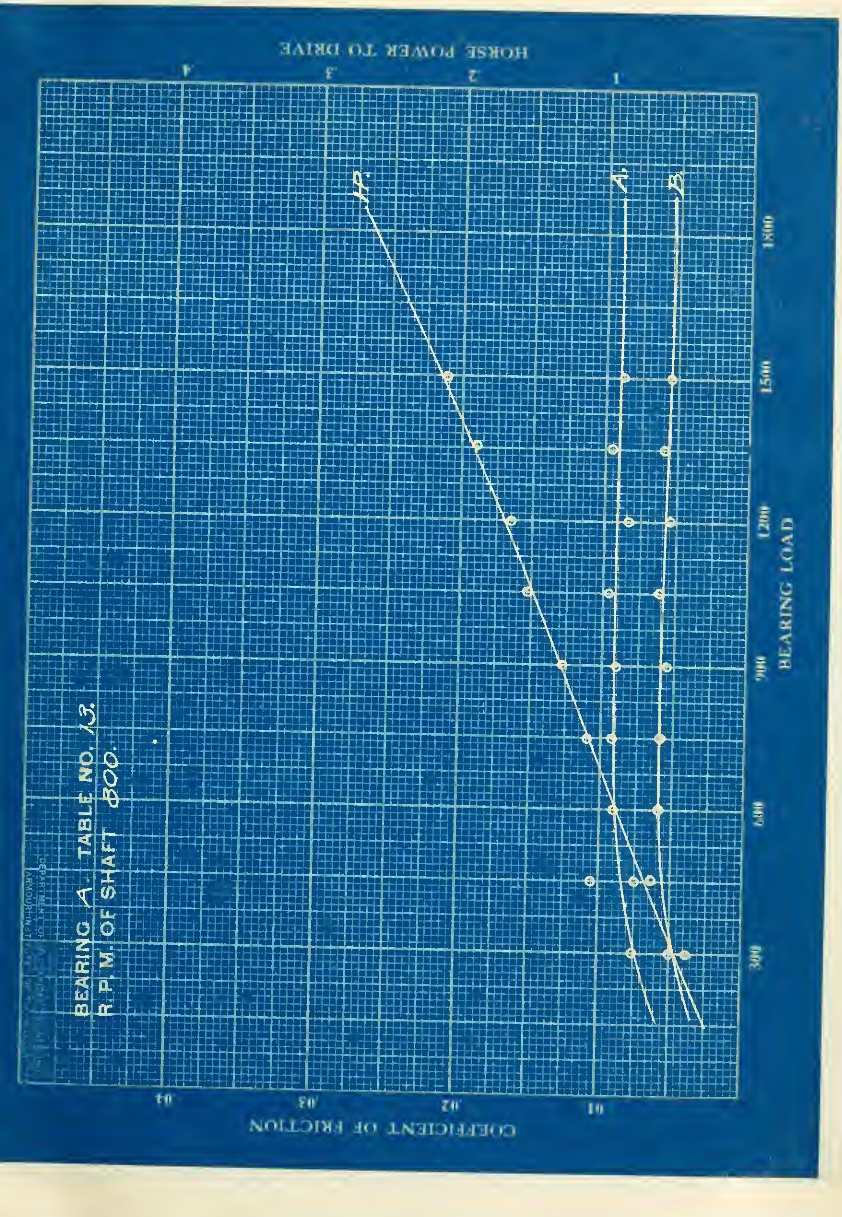


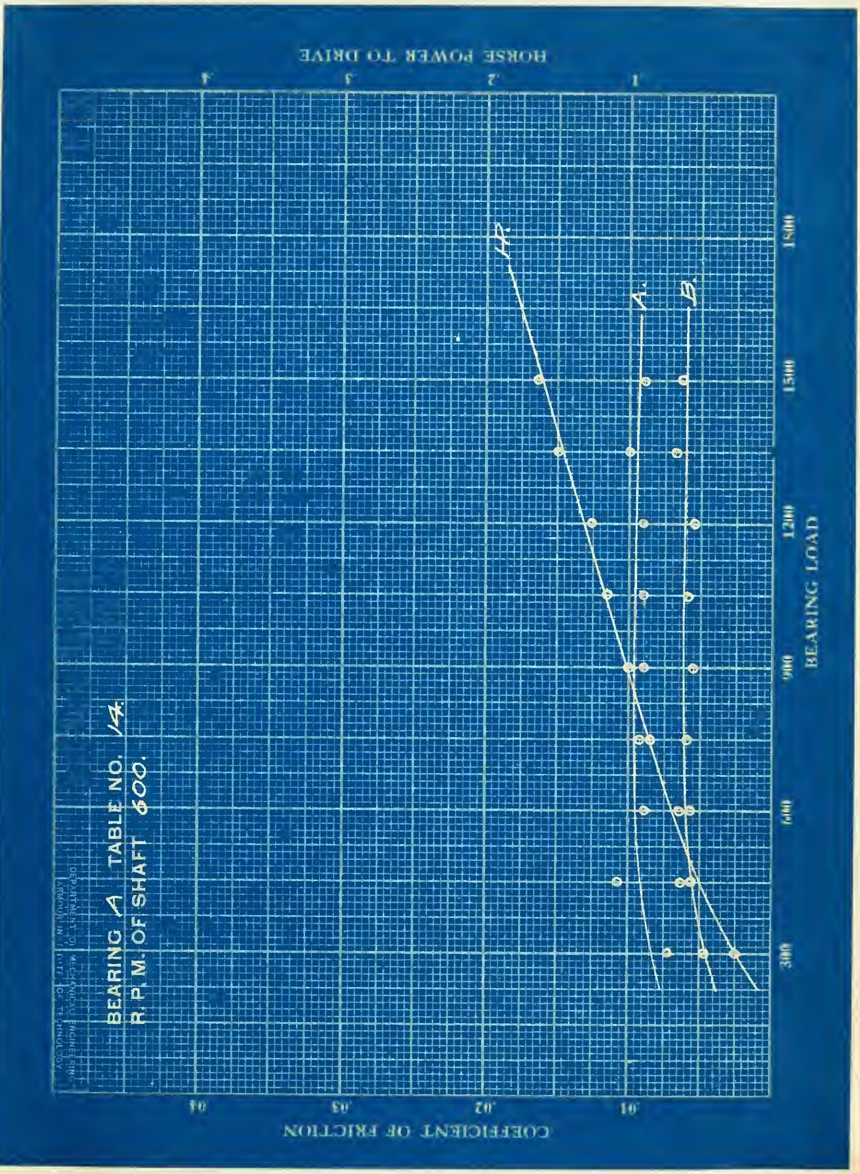
BEARING A TABLE NO. 9
BEARING LOAD 300 LBS.
ROOM TEMP. 75°F.
HORSE POWER TO DRIVE
.1
.2
.3
.4
H
A
B
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400

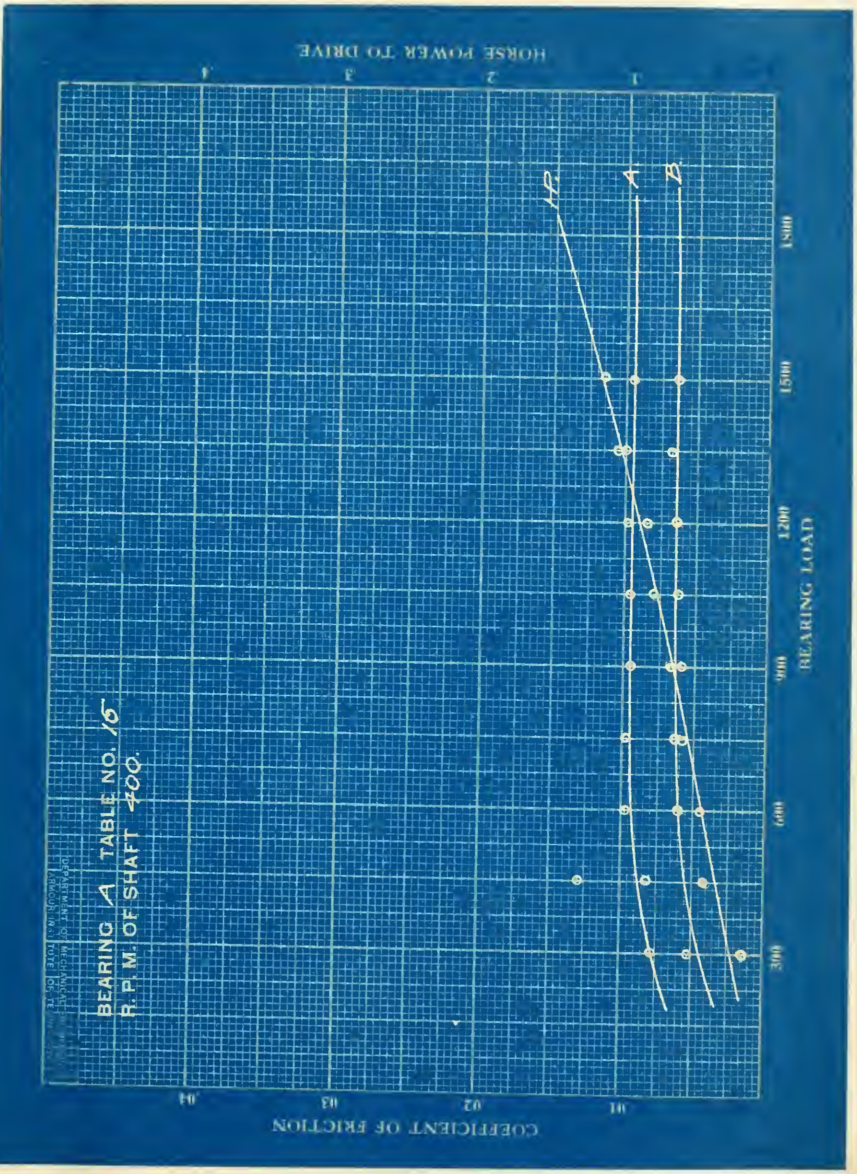

BEARING A TABLE NO. 10
R. P. M. OF SHAFT 2000
HORSE POWER TO DRIVE
COEFFICIENT OF FRICTION
BEARING LOAD
HP
A
B
300
600
900
1200
1500
1800
.01
.02
.03
.04
1
2
3
4

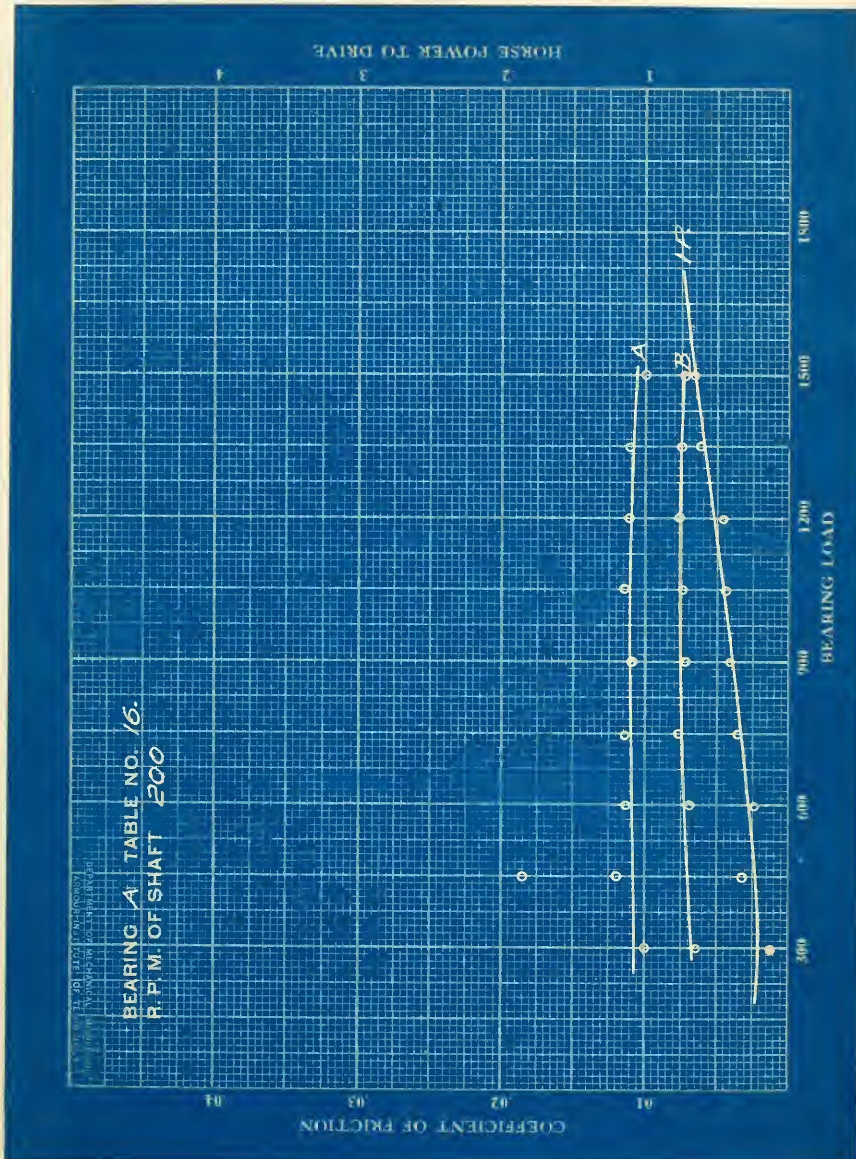

BEARING A TABLE NO. 11.
R. P. M. OF SHAFT 1600
HORSE POWER TO DRIVE
1
2
3
4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
BEARING LOAD
300
600
900
1200
1500
1800
HP
A
B


BEARING A. TABLE NO. 12
R. P. M. OF SHAFT 1200
DEPARTMENT OF MECHANICAL ENGINEERING
ARMOUR INSTITUTE OF TECHNOLOGY
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
BEARING LOAD
300
600
900
1200
1500
1800
HP.
A.
B.


BEARING A. TABLE NO. 13.
R.P.M. OF SHAFT 800.
HORSE POWER TO DRIVE
1
2
3
4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
BEARING LOAD
300
600
900
1200
1500
1800
HP.
A.
B.


BEARING A TABLE NO. 14.
R.P.M. OF SHAFT 600.
DEPARTMENT OF MECHANICAL ENGINEERING
ARMOUR INSTITUTE OF TECHNOLOGY
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
BEARING LOAD
300
600
900
1200
1500
1800
HP.
A.
B.


BEARING A TABLE NO. 15
R. P. M. OF SHAFT 400.
HORSE POWER TO DRIVE
1
2
3
4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
BEARING LOAD
300
600
900
1200
1500
1800
H.P.
A
B



BEARING A TABLE NO. 16.
R.P.M. OF SHAFT 200
HORSE POWER TO DRIVE
1
2
3
4
BEARING LOAD
300
600
900
1200
1500
1800
COEFFICIENT OF FRICTION
.01
.02
.03
.04
A
B
H.P.

BEARING "B"

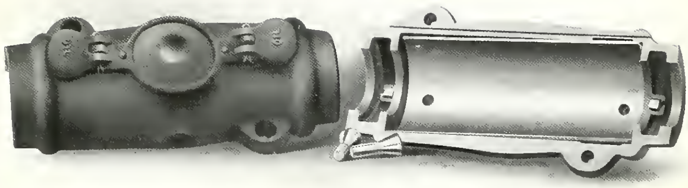


Fig. 6

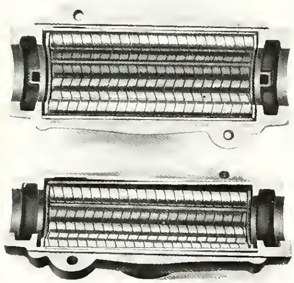


Fig. 7

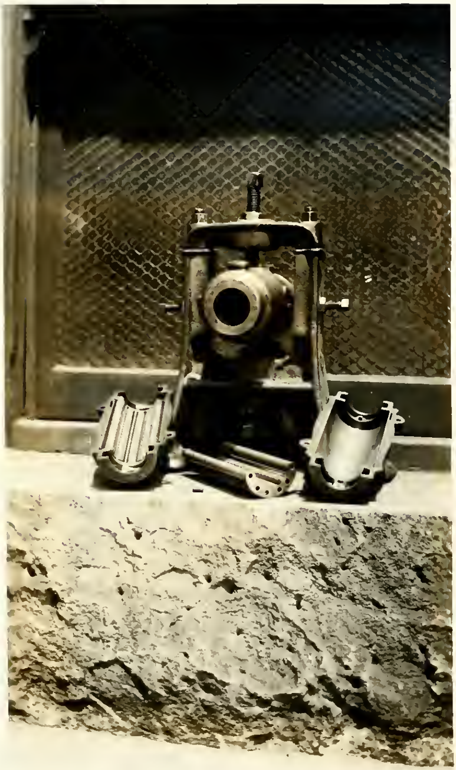


Fig. 8

BEARING "B"

Bearing "B", (Figures 6,7,8), has as its distinctive feature, a flexible roller which is made from a strip of steel wound into a helical coil or spring of uniform diameter. There are eleven of the coiled rolls in each bearing, six of them coiled in the right hand direction and five in the left hand direction. (Fig.7) The rolls are held in a separator and they run directly on the shaft.

The box is of iron, cast in two parts and lined with steel; the steel serving the purpose of an outer raceway for the rolls. (Fig.6)

The greatest advantage of a roller of this construction is, that it is flexible, which enables it to present a bearing surface along its entire length resulting in a uniform distribution of the load. The roller adjusts itself to any irregularity in the rubbing surface. The roller being hollow acts as an

oil reservoir, thereby, assuring good lubrication at all times.

These bearings could not be run over seven hundred revolutions, it being the claim of the firm manufacturing this bearing that it is built only for ordinary line shaft purposes; in other words, at speeds of 300 to 400 R.P.M.

At such speeds these bearings showed a tendency to heat up, but, not to any great extent on the lighter loads.

These rollers can be made longer than a solid roller, because, they are flexible, whereas, a solid roll does not bend to the deflection of the shaft. But, there is a disadvantage to this roller just as there is to the solid ones. It requires power to flex a spring, therefore, the constant working of these resilient rolls to allow for irregularities of alignment and surface must absorb an appreciable amount of power which is dissipated as heat.

TABLES 1 - 13

OF

BEARING "B"

BEARING B

Table No. 1 Date July 6th, 1915.

Bearing Load, LBS. 1500 Time, beginning of run 10:06 A.M.

Room Temp.° Fahr. 72 Time, end of run 10:30 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.68	745	21.40	0.253	0.0117	0.0089
0.65	653	20.48	0.212	0.0112	0.0085
0.62	632	19.52	0.196	0.0107	0.0081
0.595	617	18.72	0.184	0.0103	0.0078
0.58	603	18.26	0.175	0.0100	0.0076
0.54	559	17.00	0.151	0.0093	0.0071
0.525	456	16.51	0.120	0.0091	0.0069
0.495	443	15.58	0.110	0.0085	0.0064
0.45	390	14.16	0.088	0.0078	0.0059
0.42	328	13.23	0.069	0.0073	0.0055
0.39	283	12.28	0.055	0.0061	0.0051
0.305	224	11.50	0.041	0.0063	0.0048
0.35	178	11.00	0.031	0.0060	0.0046

Remarks:—

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

BEARING B

Table No. 2 Date July 6th, 1915.

Bearing Load, LBS. 1350 Time, beginning of run 10:30 A.M.

Room Temp.° Fahr. 72 Time, end of run 11:10 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.585	729	18.41	0.213	0.0112	0.0085
0.56	708	17.65	0.198	0.0107	0.0081
0.535	657	16.85	0.176	0.0102	0.0077
0.51	633	16.07	0.161	0.0098	0.0074
0.49	599	15.42	0.147	0.0094	0.0071
0.455	536	14.35	0.122	0.0087	0.0066
0.42	495	13.22	0.104	0.0080	0.0061
0.39	410	12.28	0.080	0.0075	0.0057
0.365	373	11.48	0.068	0.0070	0.0053
0.335	271	10.54	0.045	0.0064	0.0048
0.31	207	9.76	0.032	0.0059	0.0045
0.30	174	9.45	0.026	0.0057	0.0043

Remarks:—

BEARING B

Table No. 3 — Date July 6th, 1915.

Bearing Load, LBS. 1200 — Time, beginning of run 11:18 A.M.

Room Temp.° Fahr. 72 — Time, end of run 11:30 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.555	771	17.50	0.214	0.0120	0.0091
0.50	689	15.75	0.172	0.0108	0.0082
0.48	662	15.12	0.159	0.0103	0.0078
0.45	611	14.18	0.137	0.0094	0.0071
0.395	510	12.45	0.101	0.0085	0.0064
0.36	436	11.34	0.079	0.0078	0.0059
0.305	262	9.62	0.040	0.0066	0.0050
0.285	183	8.97	0.026	0.0061	0.0046

Remarks:—

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

BEARING B

Table No. 4 Date July 6th, 1915.

Bearing Load, LBS. 1050 Time, beginning of run 11:30 A.M.

Room Temp.° Fahr. 72 Time, end of run 11:46 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.495	758	15.57	0.188	0.0122	0.0092
0.45	674	14.18	0.152	0.0111	0.0084
0.425	628	13.38	0.133	0.0105	0.0079
0.40	589	12.58	0.118	0.0099	0.0075
0.37	524	11.64	0.097	0.0091	0.0069
0.315	400	9.92	0.063	0.0078	0.0059
0.28	285	8.82	0.040	0.0069	0.0052
0.25	196	7.87	0.025	0.0062	0.0047

Remarks:—

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]

BEARING B

Table No. 5 Date July 6th, 1915.

Bearing Load, LBS. 900 Time, beginning of run 11:46 A.M.

Room Temp.° Fahr. 72 Time, end of run 11:56 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.46	730	14.48	0.168	0.0132	0.0100
0.425	676	13.37	0.144	0.0122	0.0092
0.395	614	12.42	0.121	0.0113	0.0086
0.345	490	10.87	0.085	0.0099	0.0075
0.285	311	8.97	0.044	0.0082	0.0062
0.25	205	7.87	0.026	0.0072	0.0055
0.235	132	7.39	0.016	0.0067	0.0051

Remarks:—

BEARING B

Table No. 6 Date July 6th, 1915.

Bearing Load, LBS. 750 Time, beginning of run 11:56 A.M.

Room Temp.° Fahr. 72 Time, end of run 12:10 P.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.44	743	13.82	0.163	0.0151	0.0114
0.40	667	12.57	0.134	0.0138	0.0104
0.35	574	11.02	0.100	0.0121	0.0092
0.32	492	10.08	0.079	0.0110	0.0083
0.265	328	8.35	0.043	0.0091	0.0069
0.23	265	7.24	0.031	0.0079	0.0060
0.22	147	6.93	0.016	0.0076	0.0058

Remarks:—

BEARING B

Table No. 7 Date July 6th, 1915.

Bearing Load, LBS. 600 Time, beginning of run 12:10 P.M.

Room Temp.° Fahr. 72 Time, end of run 12:30 P.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.41	719	12.89	0.147	0.0176	0.0133
0.375	672	11.79	0.126	0.0161	0.0122
0.335	574	10.53	0.096	0.0144	0.0109
0.30	493	9.45	0.074	0.0129	0.0098
0.255	329	8.03	0.042	0.0110	0.0083
0.255	334	8.03	0.043	0.0110	0.0083
0.24	305	7.55	0.037	0.0103	0.0078
0.225	274	7.08	0.031	0.0097	0.0073
0.215	217	6.76	0.023	0.0093	0.0070
0.20	155	6.29	0.016	0.0086	0.0065

Remarks:—

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

BEARING B

Table No. 8 Date July 6th, 1915.

Bearing Load, LBS. 450 Time, beginning of run 12:30 P.M.

Room Temp.° Fahr. 72 Time, end of run 12:45 P.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.40	730	12.60	0.146	0.0230	0.0174
0.36	663	11.35	0.119	0.0207	0.0157
0.33	597	10.40	0.098	0.0190	0.0144
0.29	504	9.13	0.073	0.0167	0.0126
0.25	342	7.88	0.042	0.0144	0.0109
0.205	240	6.46	0.025	0.0118	0.0089
0.19	164	5.98	0.016	0.0109	0.0082

Remarks:—

BEARING B

Table No. 9 Date July 6th, 1915.

Bearing Load, LBS. 300 Time, beginning of run 12:45 P.M.

Room Temp.° Fahr. 72 Time, end of run 12:55 P.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.365	734	11.50	0.134	0.0316	0.0239
0.335	675	10.55	0.113	0.0289	0.0219
0.30	592	9.75	0.089	0.0259	0.0196
0.265	481	8.35	0.064	0.0229	0.0173
0.225	372	7.08	0.042	0.0194	0.0147
0.195	264	6.14	0.026	0.0168	0.0127
0.175	155	5.52	0.014	0.0151	0.0114

Remarks:—

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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DATA INTERPOLATED
FROM TABLES 1—9

Bearing B

R. P. M. of Shaft 800

Table No. 10

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
1500		0.0120	0.0097
1350		0.0120	0.0097
1200	0.23	0.0120	0.0095
1050	0.223	0.0130	0.0098
900	0.210	0.0147	0.0115
750	0.195	0.0160	0.0125
600	0.195	0.0135	0.0140
450	0.185	0.025	0.0193
300	0.160	0.036	0.026

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing B

R. P. M. of Shaft 600

Table No. 11

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
1500	0.170	0.0100	0.0077
1350	0.14	0.0092	0.0072
1200	0.135	0.0092	0.0070
1050	0.120	0.010	0.0075
900	0.1150	0.0115	0.0085
750	0.110	0.0123	0.0095
600	0.105	0.0148	0.011
450	0.100	0.0190	0.0142
300	0.092	0.0262	0.020

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing B

R. P. M. of Shaft 400

Table No. 12

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.09	0.008	0.006
1350	0.065	0.0073	0.0055
1200	0.070	0.0075	0.0054
1050	0.063	0.0080	0.0055
900	0.057	0.0090	0.0065
750	0.055	0.0095	0.0075
600	0.052	0.0115	0.0065
450	0.048	0.0145	0.0108
300	0.045	0.020	0.0150

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing B

R. P. M. of Shaft 200

Table No. 13

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
1500	0.042	0.0068	0.0050
1350	0.025	0.0060	0.0045
1200	0.032	0.0063	0.0045
1050	0.028	0.0065	0.0045
900	0.023	0.0075	0.0052
750	0.023	0.0080	0.0060
600	0.022	0.0095	0.0068
450	0.020	0.0117	0.0086
300	0.020	0.016	0.0120

Remarks:—

CURVES PLOTTED FROM

TABLES 1 - 13

OF

BEARING "B"

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[illegible]

[illegible]

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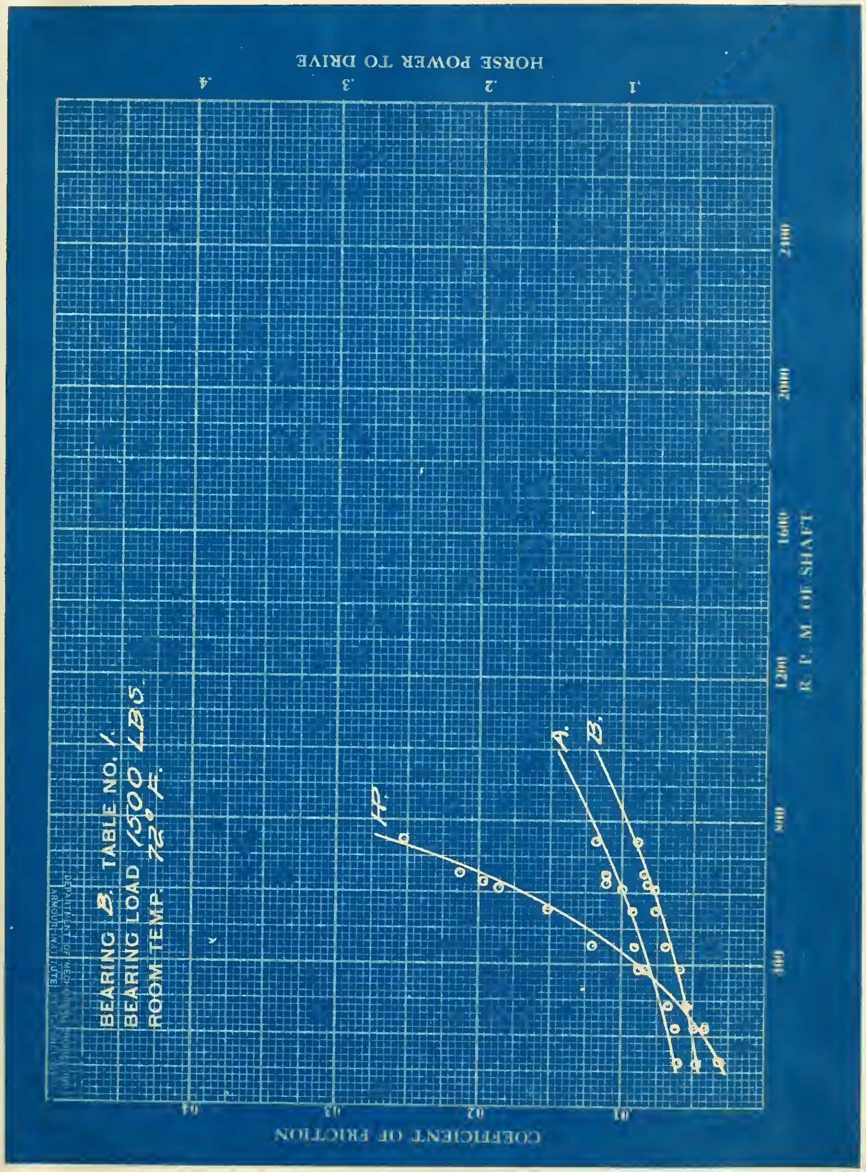
[illegible]

[illegible]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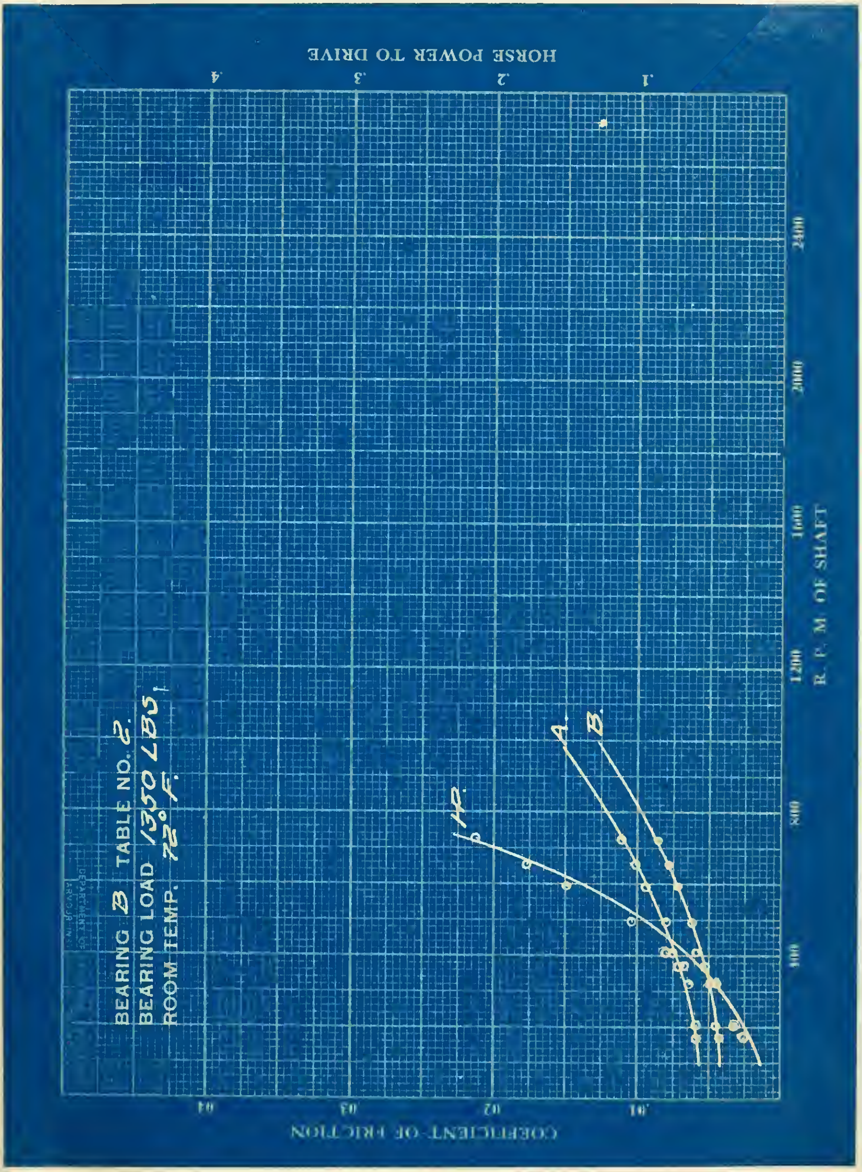
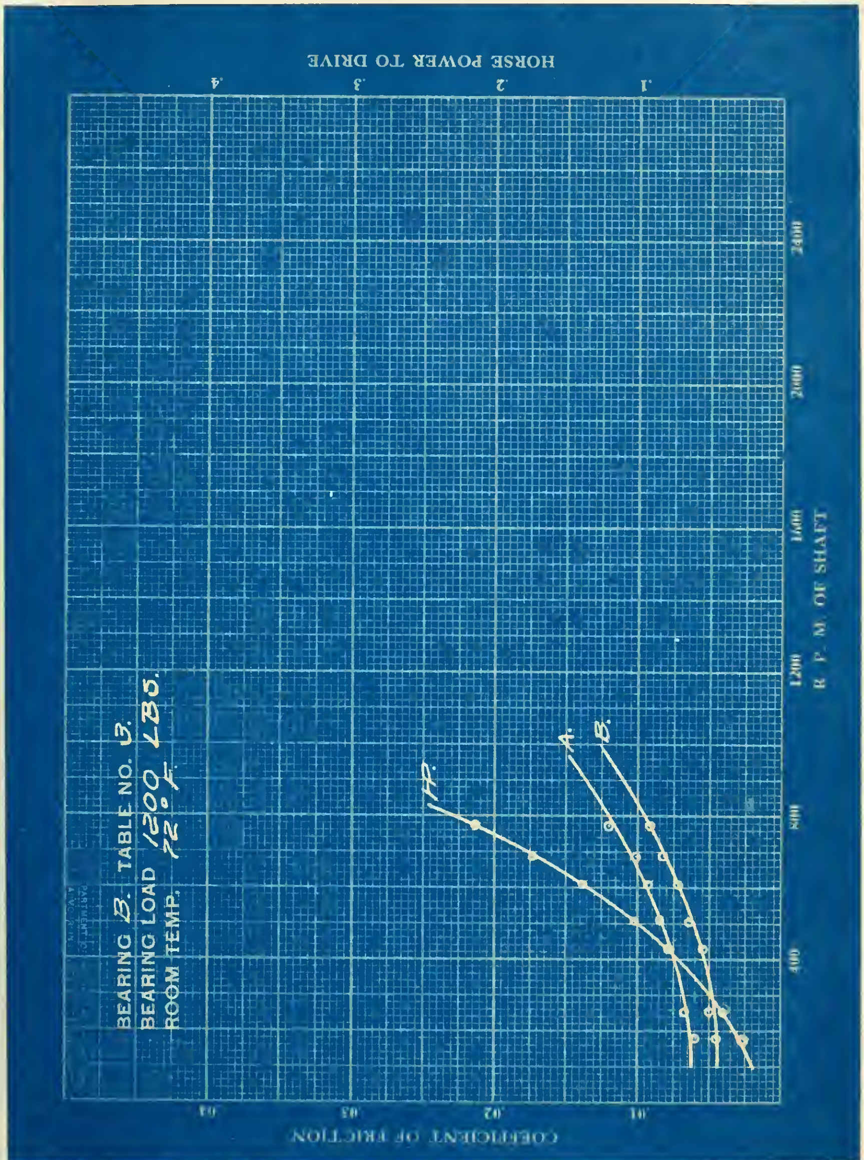
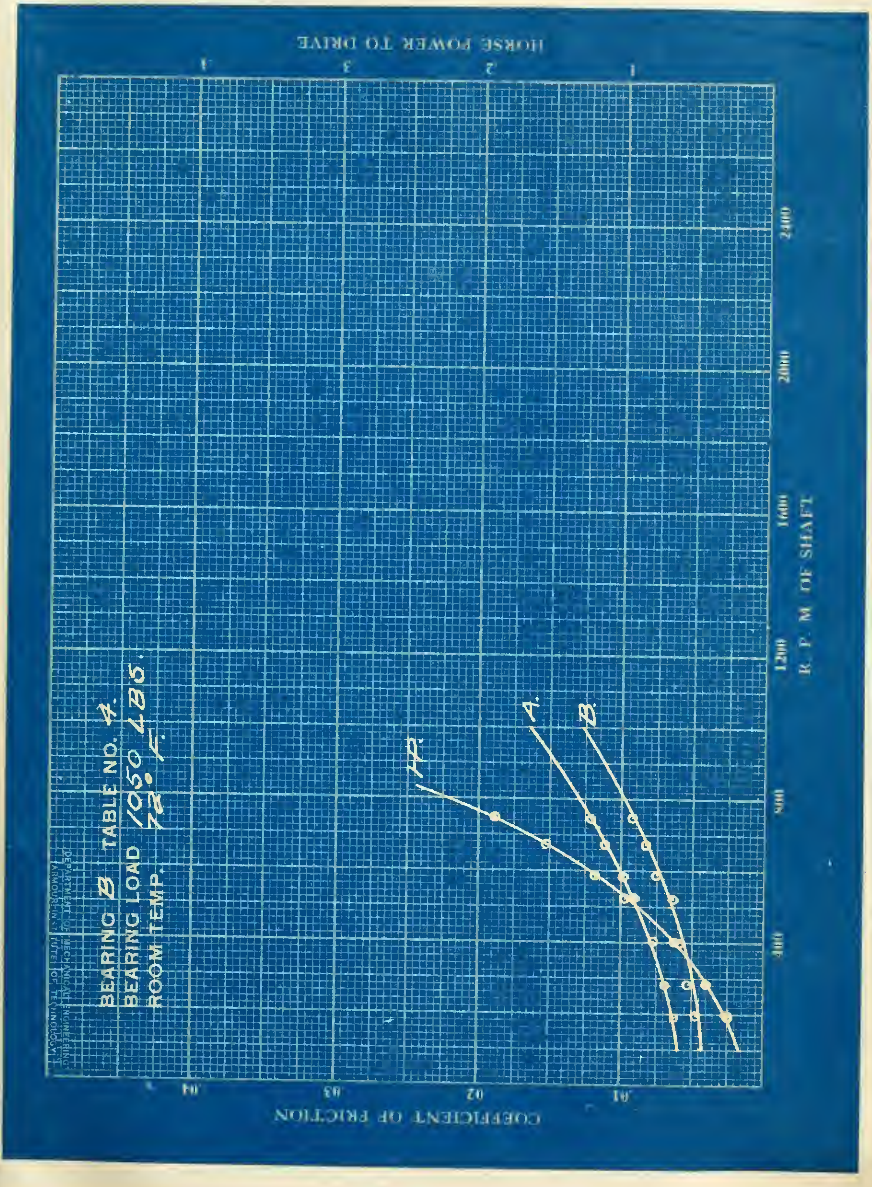
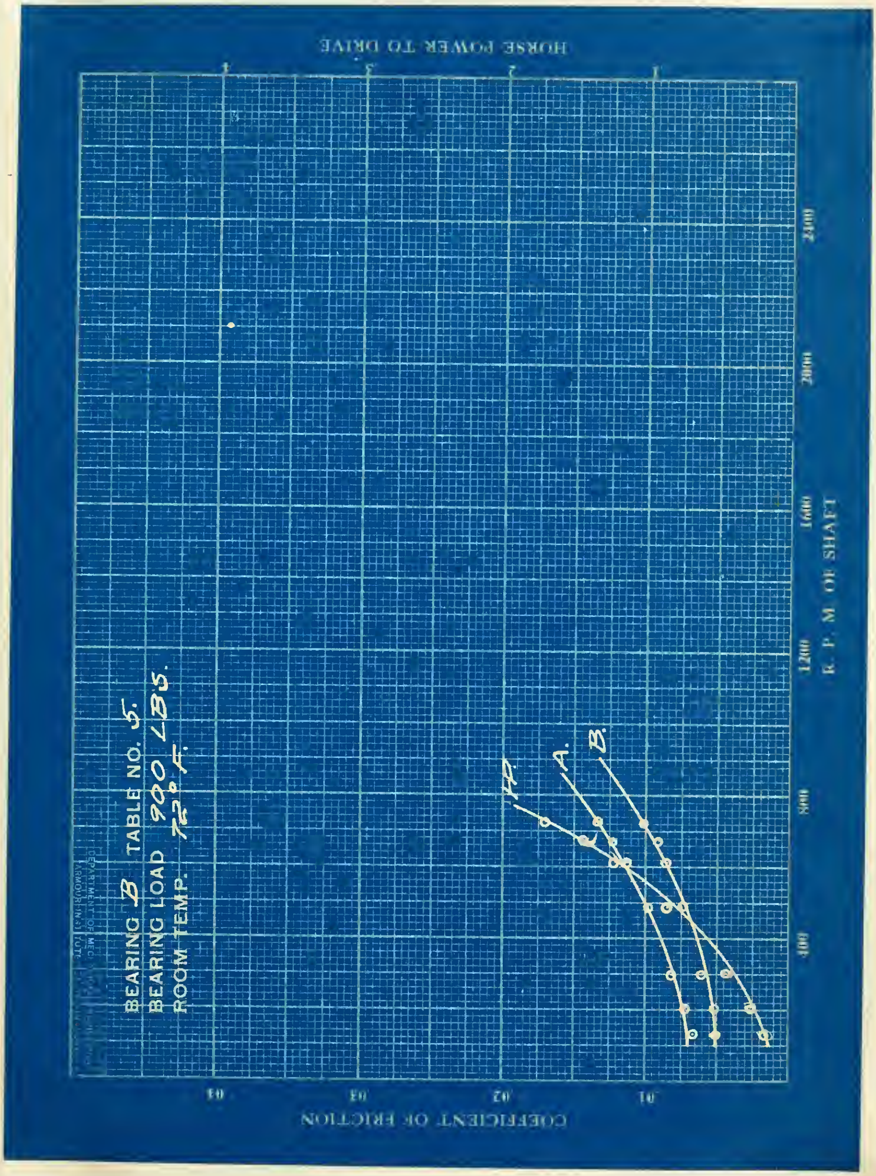
BEARING LOAD 1500 LBS.
ROOM TEMP. 72° F.
H.P.
A.
B.
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400

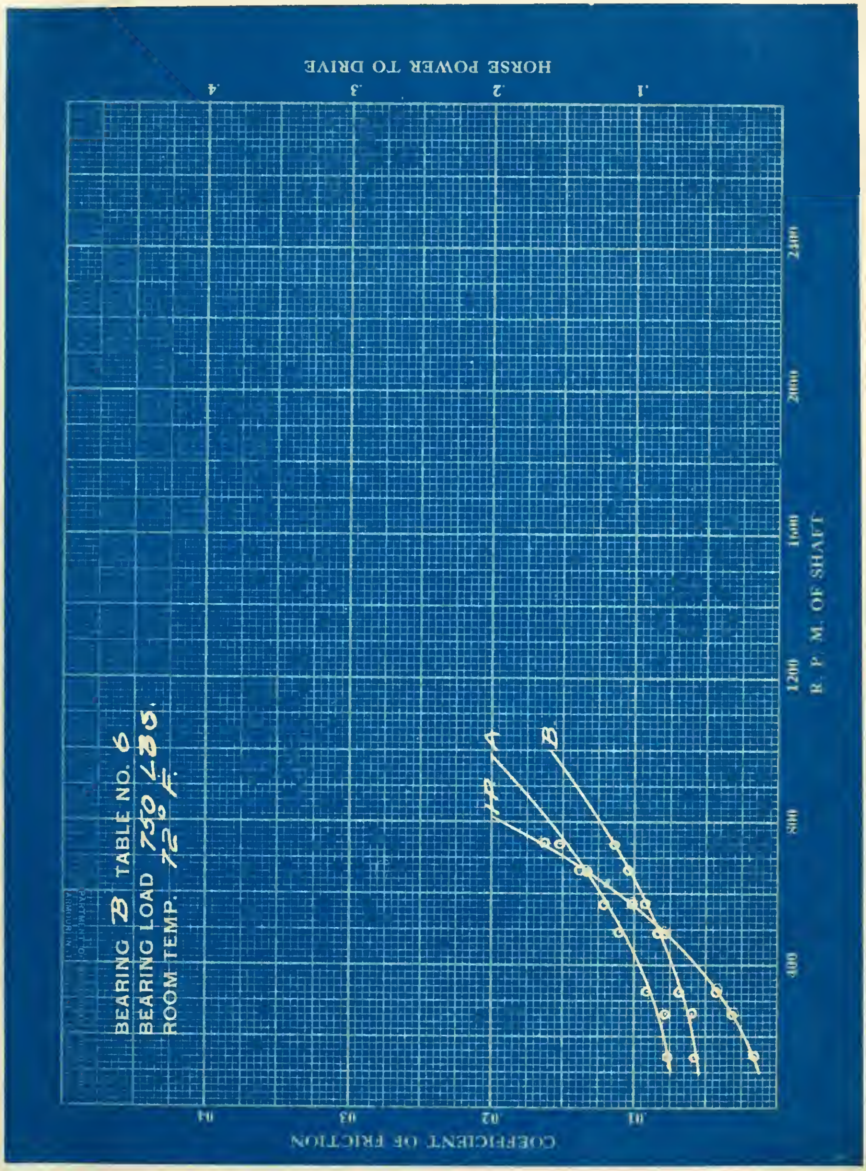

BEARING B TABLE NO. 2
BEARING LOAD 1350 LBS
ROOM TEMP. 72° F.
HORSE POWER TO DRIVE
.1
.2
.3
.4
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
COEFFICIENT OF FRICTION
.01
.02
.03
.04
H.P.
A
B

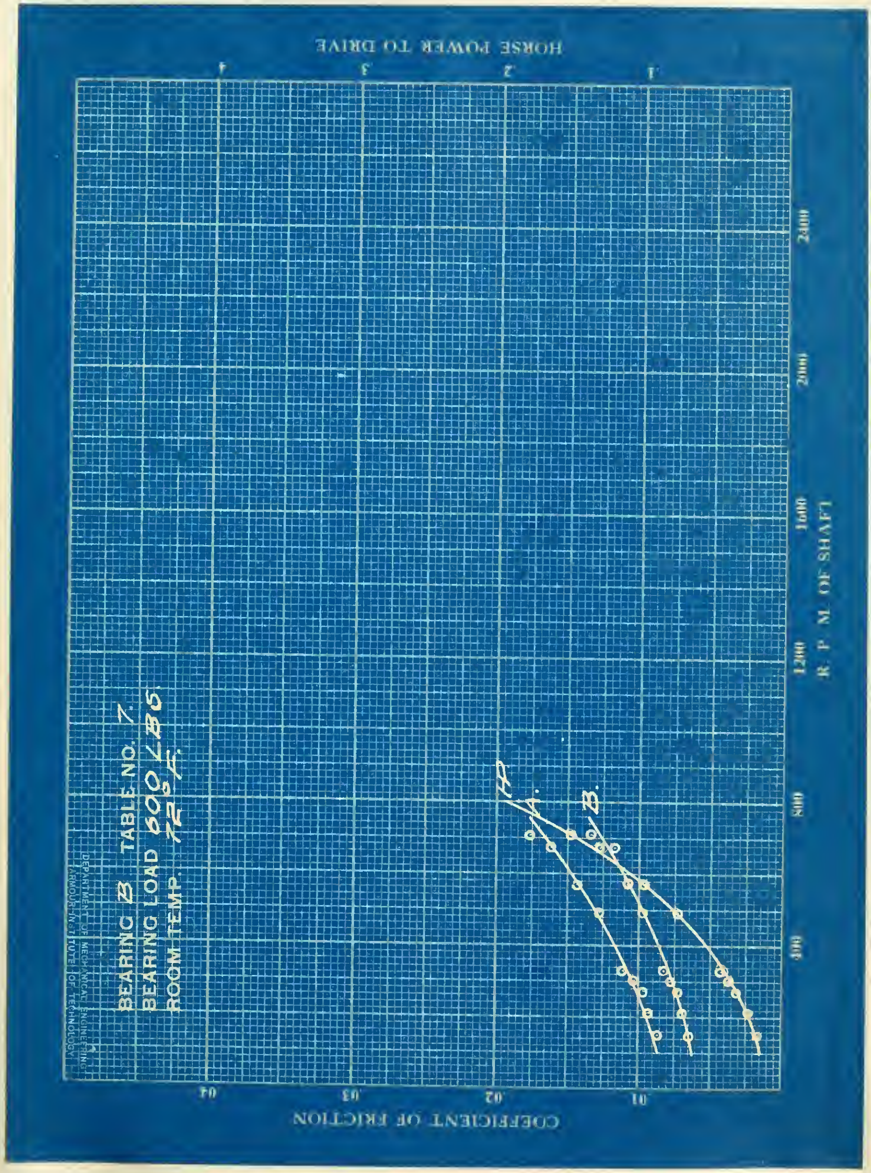


HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
BEARING B. TABLE NO. B.
BEARING LOAD 1200 LBS.
ROOM TEMP. 72° F.
HP.
A.
B.

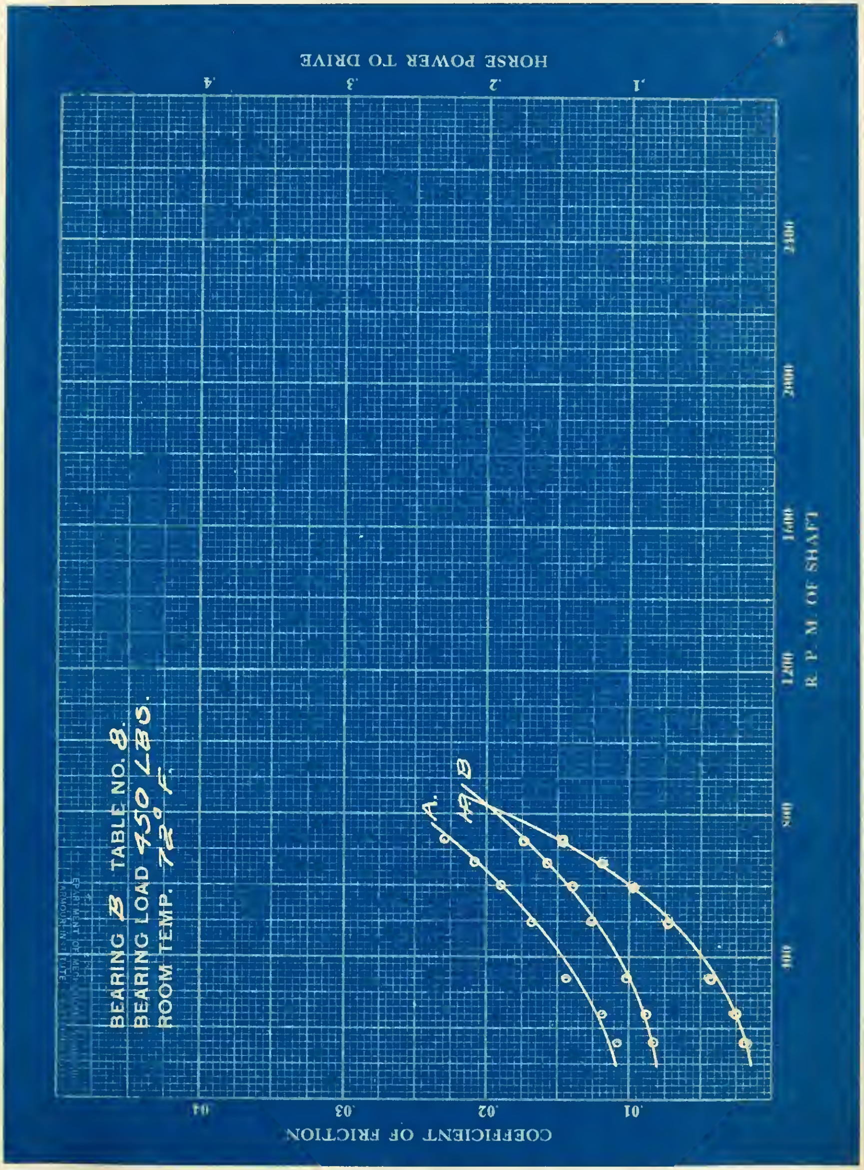

HORSE POWER TO DRIVE
1
2
3
4
BEARING B TABLE NO. 4.
BEARING LOAD 1050 LBS.
ROOM TEMP. 72° F.
DEPARTMENT OF MECHANICAL ENGINEERING
ARMOUR INSTITUTE OF TECHNOLOGY
H.P.
A.
B.
400
800
1200
1600
2000
2400
R. P. M. OF SHAFT
.01
.02
.03
.04
COEFFICIENT OF FRICTION

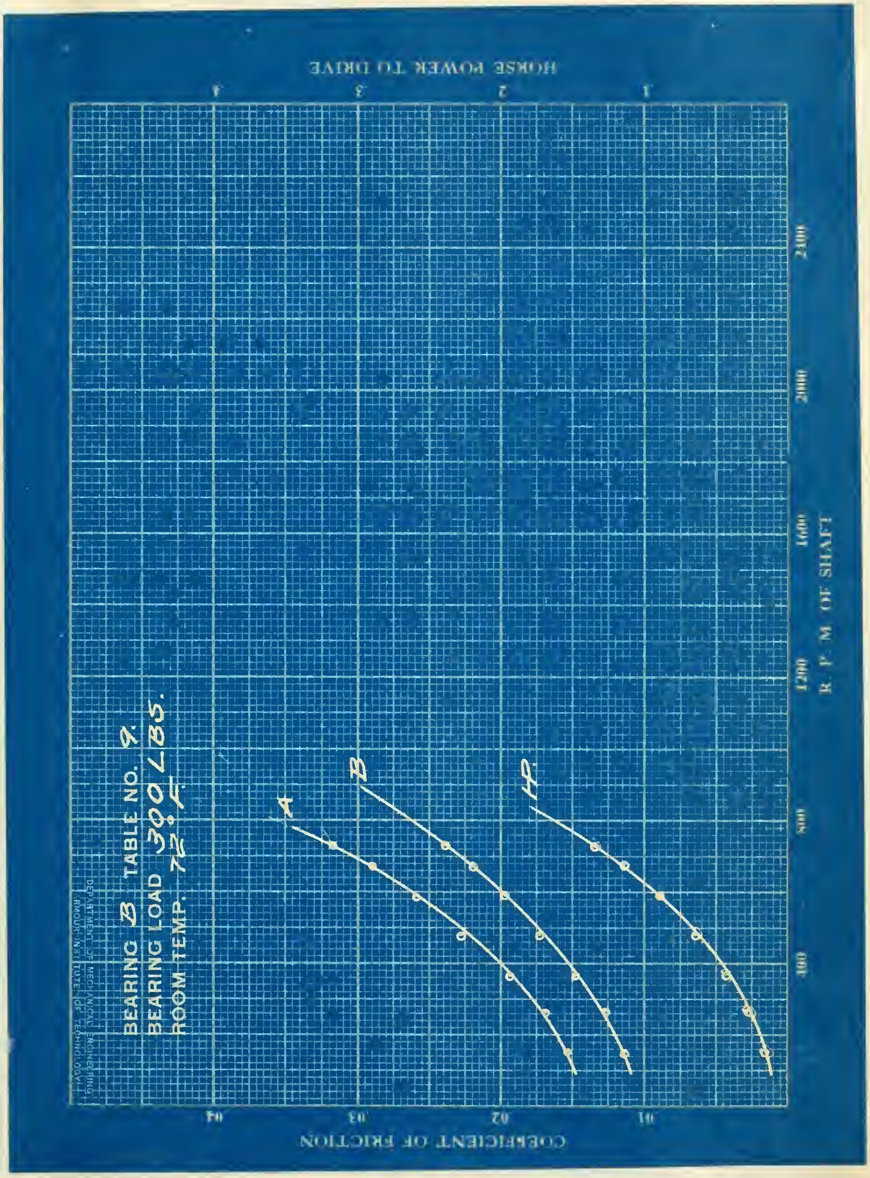

BEARING B TABLE NO. 5.
BEARING LOAD 900 LBS.
ROOM TEMP. 72° F.
HORSE POWER TO DRIVE
1
2
3
4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
HP
A.
B.


BEARING B TABLE NO. 6
BEARING LOAD 750 LBS.
ROOM TEMP. 72° F.
HORSE POWER TO DRIVE
.1
.2
.3
.4
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
COEFFICIENT OF FRICTION
.01
.02
.03
.04
HP
A
B

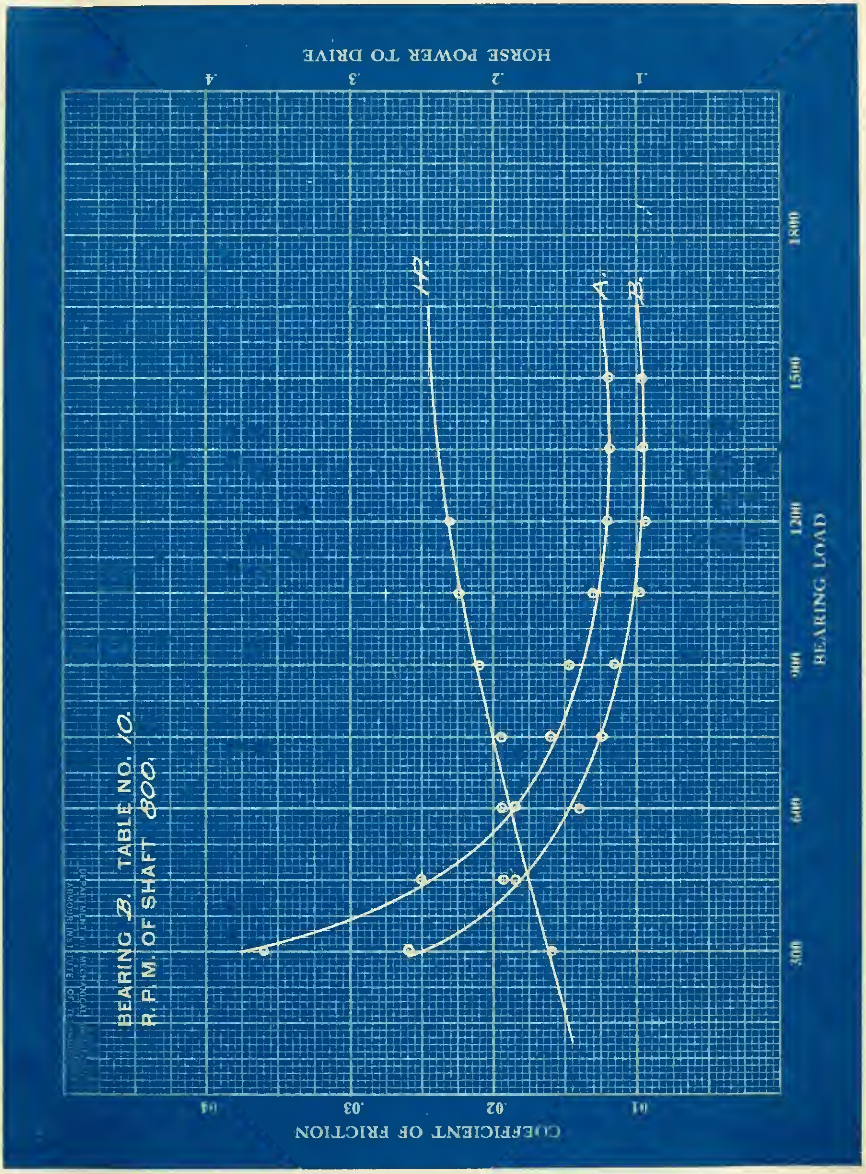


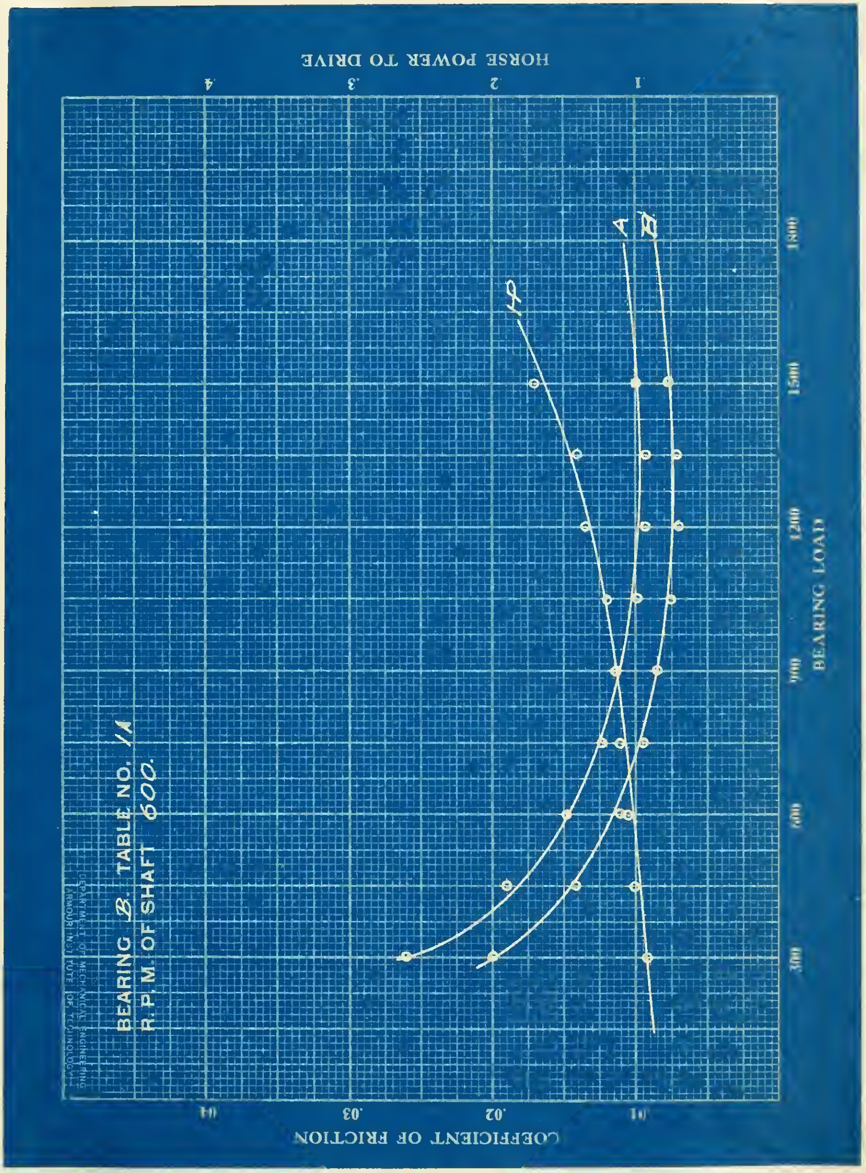
BEARING B TABLE NO. 7.
BEARING LOAD 600 LBS
ROOM TEMP. 72° F.
DEPARTMENT OF MECHANICAL ENGINEERING
ARMOUR INSTITUTE OF TECHNOLOGY
HORSE POWER TO DRIVE
R P M OF SHAFT
COEFFICIENT OF FRICTION
A
A.
B.


BEARING B TABLE NO. 8.
BEARING LOAD 450 LBS.
ROOM TEMP. 72° F.
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
A.



BEARING B TABLE NO. 9.
BEARING LOAD 300 LBS.
ROOM TEMP. 72°F.
DEPARTMENT OF MECHANICAL ENGINEERING
ARMOUR INSTITUTE OF TECHNOLOGY
A
B
H.
HORSE POWER TO DRIVE
1
2
3
4
R P M OF SHAFT
400
800
1200
1600
2000
2400
COEFFICIENT OF FRICTION
.01
.02
.03
.04


BEARING B. TABLE NO. 10.
R. P. M. OF SHAFT 800.
HORSE POWER TO DRIVE
.1
.2
.3
.4
H.P.
A.
B.
300
600
900
1200
1500
1800
BEARING LOAD
.01
.02
.03
.04
COEFFICIENT OF FRICTION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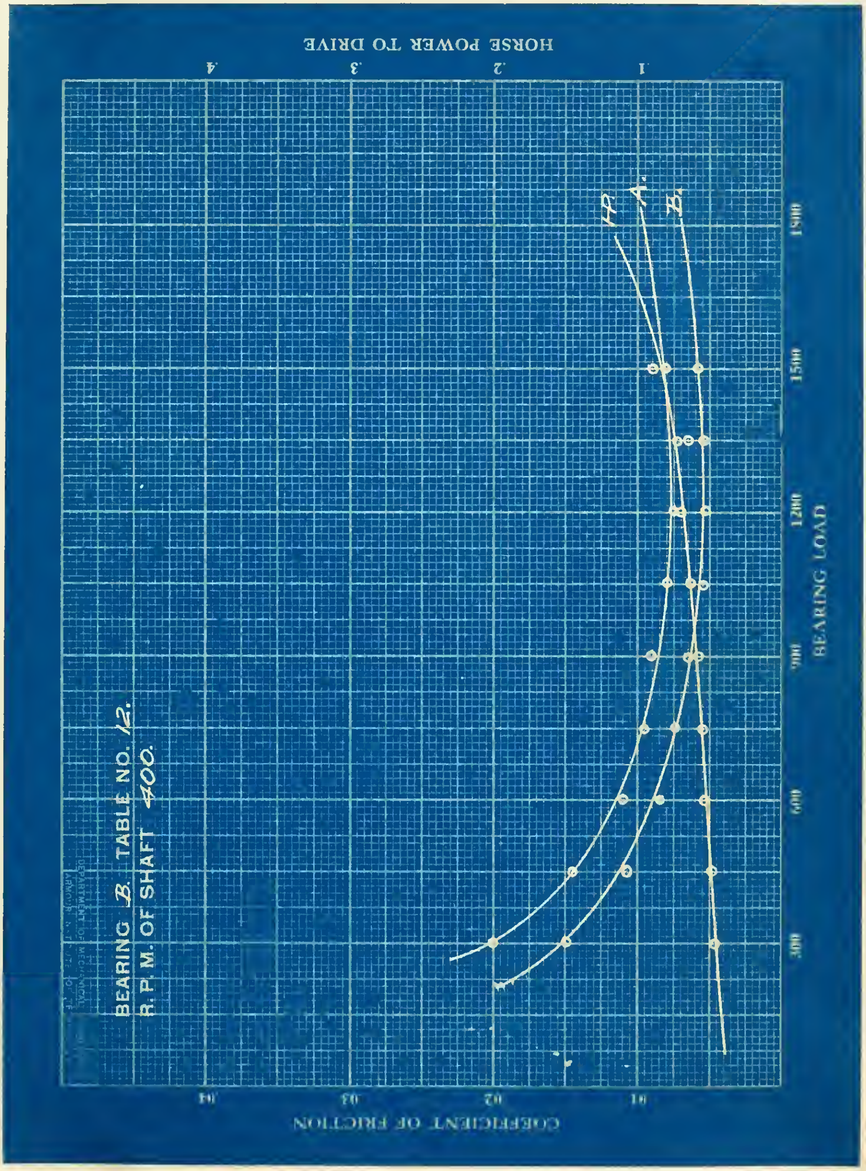
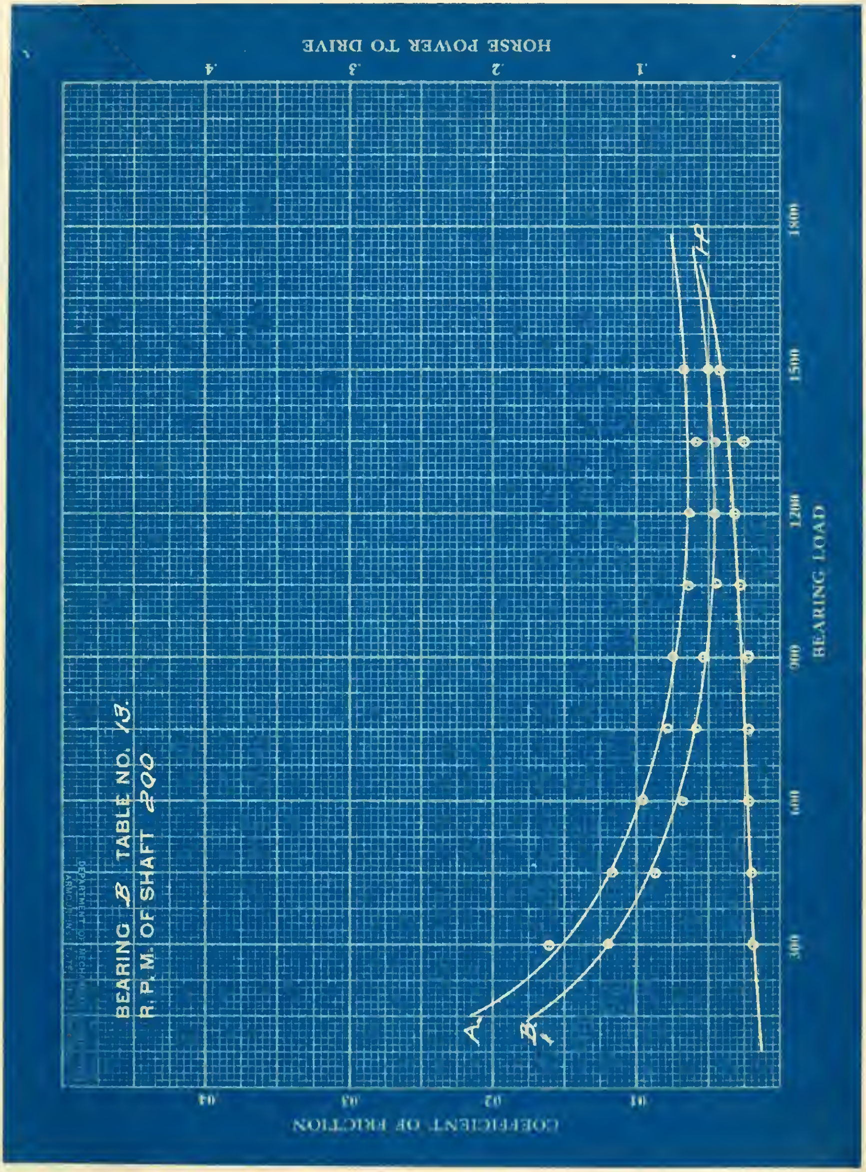
R.P.M. OF SHAFT 600.
HORSE POWER TO DRIVE
1
2
3
4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
BEARING LOAD
300
600
900
1200
1500
1800
HP
A
B
DEPARTMENT OF MECHANICAL ENGINEERING
ARMOUR INSTITUTE OF TECHNOLOGY


BEARING B. TABLE NO. 12.
R. P. M. OF SHAFT 400.
HORSE POWER TO DRIVE
COEFFICIENT OF FRICTION
BEARING LOAD
H.P.
A.
B.



HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
BEARING LOAD
300
600
900
1200
1500
1800
BEARING B TABLE NO. 13.
R. P. M. OF SHAFT 200
A
B
HP

"BEARING "C"

Fig. 9

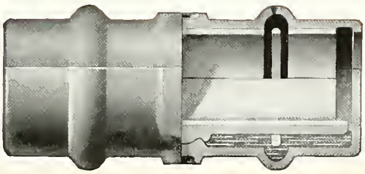


Fig. 10

BEARING "C"

Bearing "C", (Figures 9,10), is the ordinary type of ring oiled babbitt bearing. The housing contains the oil which is carried up from the reservoir to the top of the shaft from whence it is distributed along the whole bearing length. The bottom piece of babbitt is detachable and fits into the lower housing, while the top babbitt is fixed into the upper housing. The babbitt contained no oil grooves.

When this type of bearing is new, it is very economical and its coefficient of friction is low. The reason for this being that the babbitt has high spots on which the shaft runs and because the shaft runs on the high spots, the oil is pressed into the low spots at enormous pressures, thereby, giving the shaft a pressure feed oil lubrication which of necessity lowered the friction in the bearings. After the completion of the tests

on this type of bearing it was found that the bearings had only been worn on two or three high spots.

The fact that in time the high spots on the bearing will wear down so that the shaft will run on the entire babbitt surface does not mean that the friction will be less. To the contrary, the more bearing surface the shaft has, the less oil space it has and the higher the friction will be. In journal bearings, the better the lubrication, the lower the friction.

At no time during the test were we able to start the line shaft with any load on. The bearings were all as loosely adjusted as it was possible to make them, but, even so, the 20 H.P. dynamometer would not turn over the shaft when the load was on. This is certainly a very objectionable feature of this bearing. It shows that the starting or slow moving sliding friction is a long way out of proportion to that of rolling friction.

TABLES 1 - 16

OF

BEARING "C"

BEARING C

Table No. 1 Date July 9th, 1915.

Bearing Load, LBS. 1500 Time, beginning of run 8:50 A.M.

Room Temp.° Fahr. 69 Time, end of run 9:20 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.63	1474	19.85	0.465	0.0109	
0.555	1392	17.48	0.387	0.0096	
0.495	1187	15.58	0.294	0.0085	
0.46	979	14.48	0.225	0.0079	
0.445	888	14.02	0.198	0.0077	
0.425	845	13.38	0.180	0.0073	
0.43	807	12.75	0.164	0.0070	
0.385	750	12.11	0.144	0.0066	
0.375	688	11.80	0.129	0.0065	
0.365	598	11.50	0.109	0.0063	
0.335	497	10.55	0.083	0.0058	
0.34	382	10.70	0.065	0.0059	
0.34	317	10.70	0.053	0.0059	
0.345	302	10.85	0.052	0.0060	

Remarks:—

[illegible]

[illegible]

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

BEARING C

Table No. 2 Date July 9th, 1915.

Bearing Load, LBS. 1350 Time, beginning of run 9:20 A.M.

Room Temp.° Fahr. 69 Time, end of run 9:42 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.485	1508	15.28	0.366	0.0093	
0.44	1369	13.82	0.301	0.0084	
0.385	1043	12.11	0.201	0.0074	
0.365	914	11.47	0.167	0.0070	
0.355	845	11.17	0.150	0.0068	
0.34	763	10.38	0.126	0.0063	
0.32	688	10.07	0.110	0.0061	
0.305	538	9.61	0.082	0.0058	
0.30	382	9.45	0.057	0.0057	
0.30	290	9.45	0.044	0.0057	
0.315	262	9.93	0.041	0.0060	
0.32	240	10.07	0.038	0.0061	

Remarks:—

BEARING C

Table No. 3 Date July 9th, 1915.

Bearing Load, LBS. 1200 Time, beginning of run 9:42 A.M.

Room Temp.° Fahr. 69 Time, end of run 9:58 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.465	1620	13.08	0.337	0.0090	
0.37	1386	11.64	0.257	0.0080	
0.32	1060	10.08	0.169	0.0069	
0.295	920	9.28	0.136	0.0064	
0.28	833	8.82	0.117	0.0061	
0.27	773	8.50	0.104	0.0058	
0.255	653	8.04	0.083	0.0055	
0.245	530	7.72	0.065	0.0053	
0.225	328	7.08	0.037	0.0049	
0.24	242	7.56	0.029	0.0052	

Remarks:—

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

BEARING C

Table No. 4 Date July 9th, 1915.

Bearing Load, LBS. 1050 Time, beginning of run 9:58 A.M.

Room Temp.° Fahr. 69 Time, end of run 10:15 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.39	1659	12.28	0.324	0.0096	
0.335	1498	10.56	0.251	0.0083	
0.29	1273	9.13	0.185	0.0071	
0.24	934	7.56	0.112	0.0059	
0.23	819	7.25	0.094	0.0057	
0.225	753	7.08	0.085	0.0055	
0.21	607	6.62	0.064	0.0052	
0.195	415	6.14	0.040	0.0048	
0.195	267	6.14	0.026	0.0048	
0.185	223	5.83	0.021	0.0046	

Remarks:—

BEARING C

Table No. 5 Date July 9th, 1915.

Bearing Load, LBS. 900 Time, beginning of run 10:15 A.M.

Room Temp.° Fahr. 69 Time, end of run 10:30 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.365	1618	11.50	0.295	0.0105	
0.32	1448	10.08	0.231	0.0092	
0.28	1258	8.82	0.176	0.0081	
0.245	1118	7.73	0.137	0.0072	
0.215	933	6.78	0.100	0.0062	
0.205	863	6.46	0.088	0.0059	
0.20	796	6.30	0.080	0.0058	
0.195	728	6.46	0.075	0.0059	
0.200	561	6.30	0.056	0.0058	
0.195	481	6.14	0.047	0.0056	
0.185	373	5.83	0.035	0.0053	
0.17	276	5.36	0.024	0.0049	
0.175	240	5.52	0.021	0.0050	

Remarks:—

BEARING C

Table No. 6 Date July 9th, 1915.

Bearing Load, LBS. 750 Time, beginning of run 10:35 A.M.

Room Temp.° Fahr. 69 Time, end of run 10:50 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.355	1608	11.18	0.286	0.0122	
0.315	1472	9.92	0.232	0.0109	
0.285	1274	8.98	0.182	0.0098	
0.23	1073	7.25	0.123	0.0080	
0.215	958	6.78	0.103	0.0074	
0.20	885	6.30	0.089	0.0069	
0.19	807	5.98	0.077	0.0066	
0.185	724	5.83	0.067	0.0064	
0.175	548	5.51	0.048	0.0060	
0.165	424	5.20	0.035	0.0057	
0.155	343	4.88	0.027	0.0054	
0.155	300	4.88	0.023	0.0054	
0.15	230	4.72	0.017	0.0052	

Remarks:—

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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BEARING C

Table No. 7 Date July 9th, 1915.

Bearing Load, LBS. 700 Time, beginning of run 10:50 A.M.

Room Temp.° Fahr. 69 Time, end of run 11:05 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.325	1664	10.21	0.271	0.0140	
0.29	1500	9.13	0.218	0.0125	
0.25	1323	7.88	0.166	0.0108	
0.22	1122	6.93	0.123	0.0095	
0.19	944	5.98	0.090	0.0082	
0.17	816	5.35	0.069	0.0073	
0.145	621	4.56	0.045	0.0063	
0.125	373	3.94	0.023	0.0054	
0.115	264	3.62	0.015	0.0050	
0.11	203	3.46	0.011	0.0047	

Remarks:—

BEARING C

Table No. 8 Date July 9th, 1915.

Bearing Load, LBS. 450 Time, beginning of run 11:05 A.M.

Room Temp.° Fahr. 69 Time, end of run 11:21 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.29	1660	9.13	0.241	0.0167	
0.27	1583	8.50	0.214	0.0155	
0.245	1463	7.72	0.179	0.0141	
0.225	1224	7.08	0.137	0.0129	
0.405	1177	6.46	0.121	0.0118	
0.175	967	5.51	0.085	0.0101	
0.155	860	4.88	0.067	0.0089	
0.145	760	4.57	0.055	0.0084	
0.12	525	3.78	0.032	0.0069	
0.12	411	3.78	0.025	0.0069	
0.10	230	3.15	0.012	0.0058	
0.08	168	2.52	0.007	0.0046	

Remarks:—

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BEARING C

Table No. 9 Date July 9th, 1915.

Bearing Load, LBS. 300 Time, beginning of run 11:21 A.M.

Room Temp.° Fahr. 69 Time, end of run 11:38 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.25	1660	7.88	0.208	0.0216	
0.235	1611	7.40	0.189	0.0203	
0.22	1503	6.93	0.165	0.0190	
0.205	1248	6.46	0.128	0.0177	
0.17	1137	5.36	0.097	0.0147	
0.145	979	4.57	0.071	0.0125	
0.135	888	4.25	0.060	0.0117	
0.13	818	4.09	0.053	0.0112	
0.115	660	3.62	0.038	0.0099	
0.105	535	3.31	0.028	0.0091	
0.095	396	2.99	0.019	0.0082	
0.075	236	2.36	0.009	0.0065	
0.07	180	2.21	0.006	0.0061	

Remarks:—

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DATA INTERPOLATED FROM TABLES 1—9

Bearing C

R. P. M. of Shaft 1600

Table No. 10

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500		0.012	
1350	0.415	0.01	
1200	0.336	0.0088	
1050	0.29	0.0092	
900	0.29	0.0105	
750	0.285	0.0125	
600	0.245	0.0135	
450	0.225	0.016	
300	0.25	0.0195	

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing C

R. P. M. of Shaft 1200

Table No. 11

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.32	0.0092	
1350	0.26	0.008	
1200	0.21	0.0075	
1050	0.182	0.007	
900	0.162	0.0076	
750	0.16	0.009	
600	0.142	0.0098	
450	0.128	0.0126	
300	0.115	0.017	

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing C

R. P. M. of Shaft 1000

Table No. 12

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.23	0.008	
1350	0.195	0.007	
1200	0.155	0.007	
1050	0.137	0.006	
900	0.12	0.0066	
750	0.12	0.0077	
600	0.10	0.0084	
450	0.11	0.009	
300	0.135	0.008	

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing C

R. P. M. of Shaft 800

Table No. 13

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.16	0.007	
1350	0.14	0.0065	
1200	0.11	0.0063	
1050	0.10	0.0065	
900	0.077	0.0066	
750	0.076	0.0065	
600	0.071	0.0067	
450	0.095	0.006	
300	0.105	0.0053	

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing C

R. P. M. of Shaft 600

Table No. 14

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.105	0.006	
1350	0.1	0.0061	
1200	0.075	0.0057	
1050	0.065	0.0051	
900	0.047	0.0052	
750	0.047	0.006	
600	0.04	0.0061	
450	0.035	0.0078	
300	0.03	0.0085	

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing C

R. P. M. of Shaft 400

Table No. 15

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.068	0.006	
1350	0.065	0.006	
1200	0.047	0.0053	
1050	0.04	0.005	
900	0.027	0.0049	
750	0.027	0.0055	
600	0.020	0.0055	
450	0.017	0.006	
300	0.013	0.0065	

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing C

R. P. M. of Shaft 200

Table No. 16

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
1500	0.041	0.006	
1350	0.038	0.0064	
1200	0.028	0.205	
1050	0.022	0.0051	
900	0.020	0.005	
750	0.020	0.0053	
600	0.010	0.005	
450	0.008	0.0045	
300	0.005	0.0056	

Remarks:—

CURVES PLOTTED FROM

TABLES 1 - 16

OF

BEARING "C"

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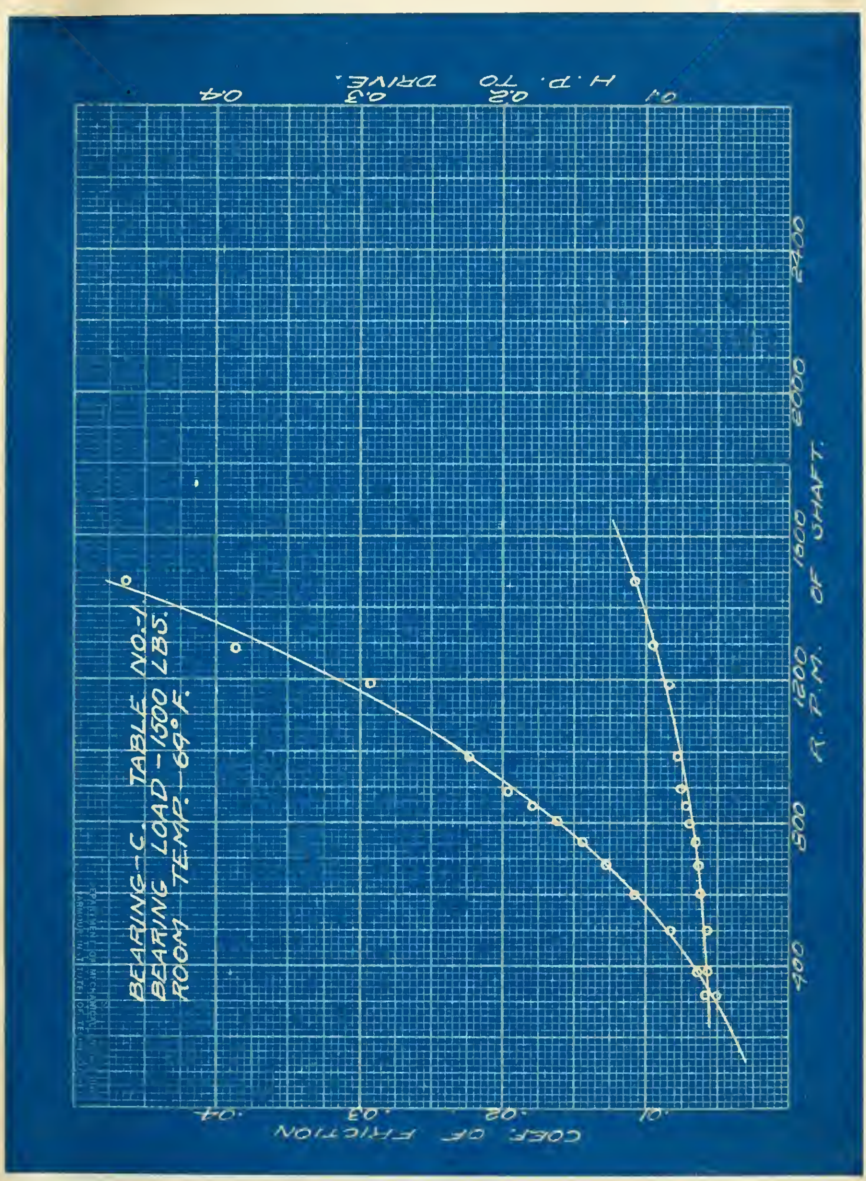
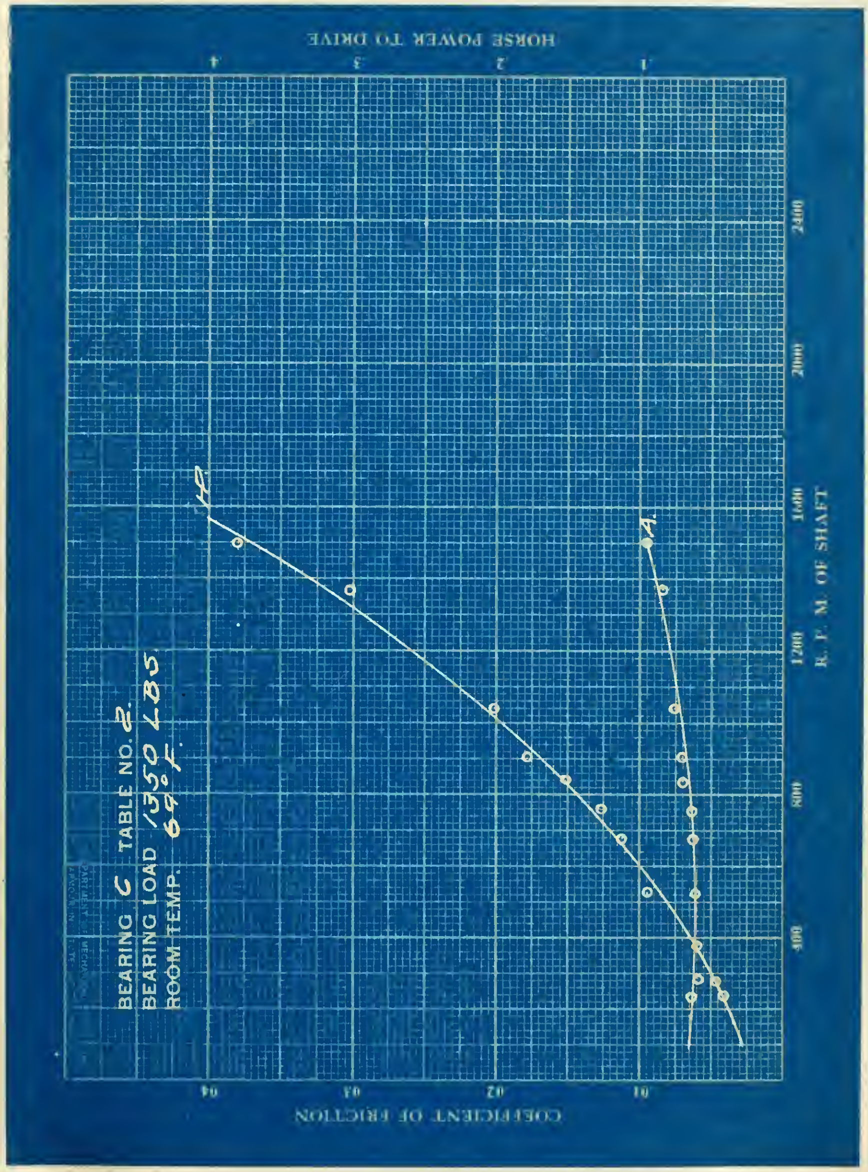
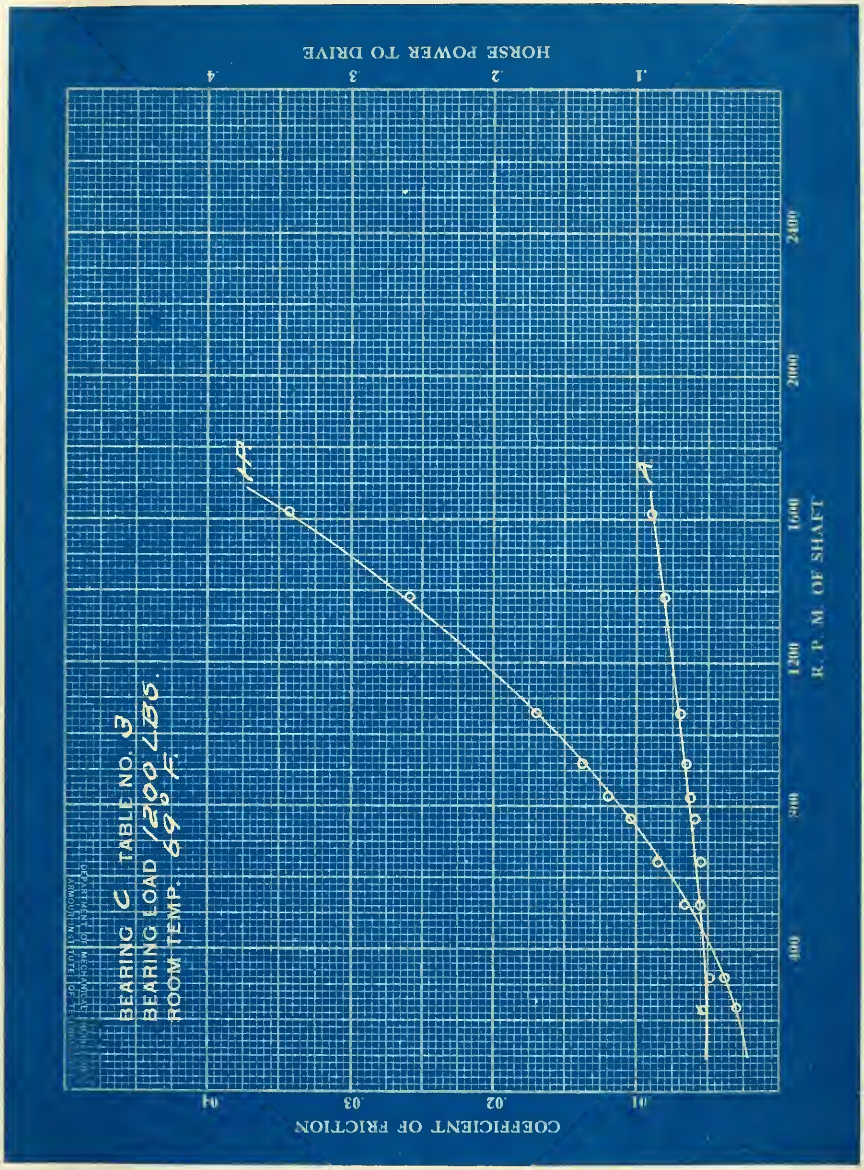
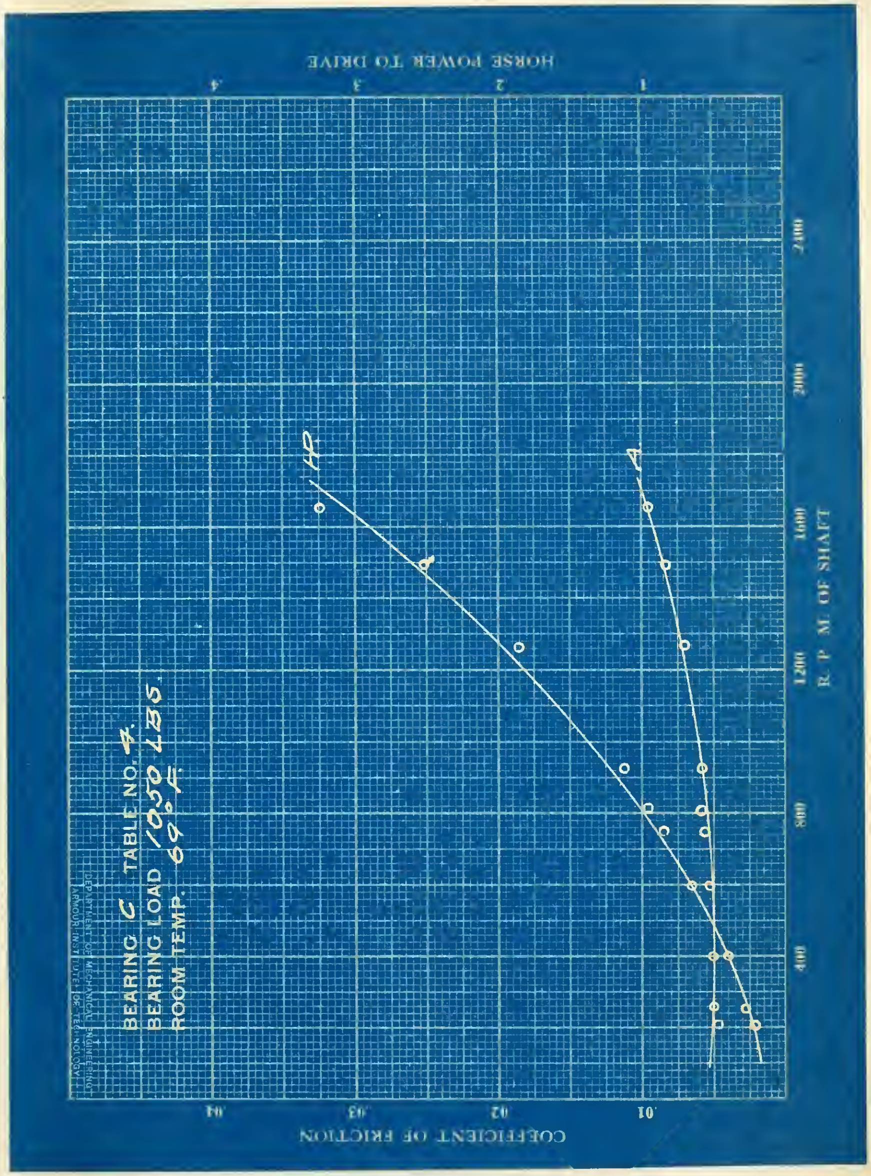


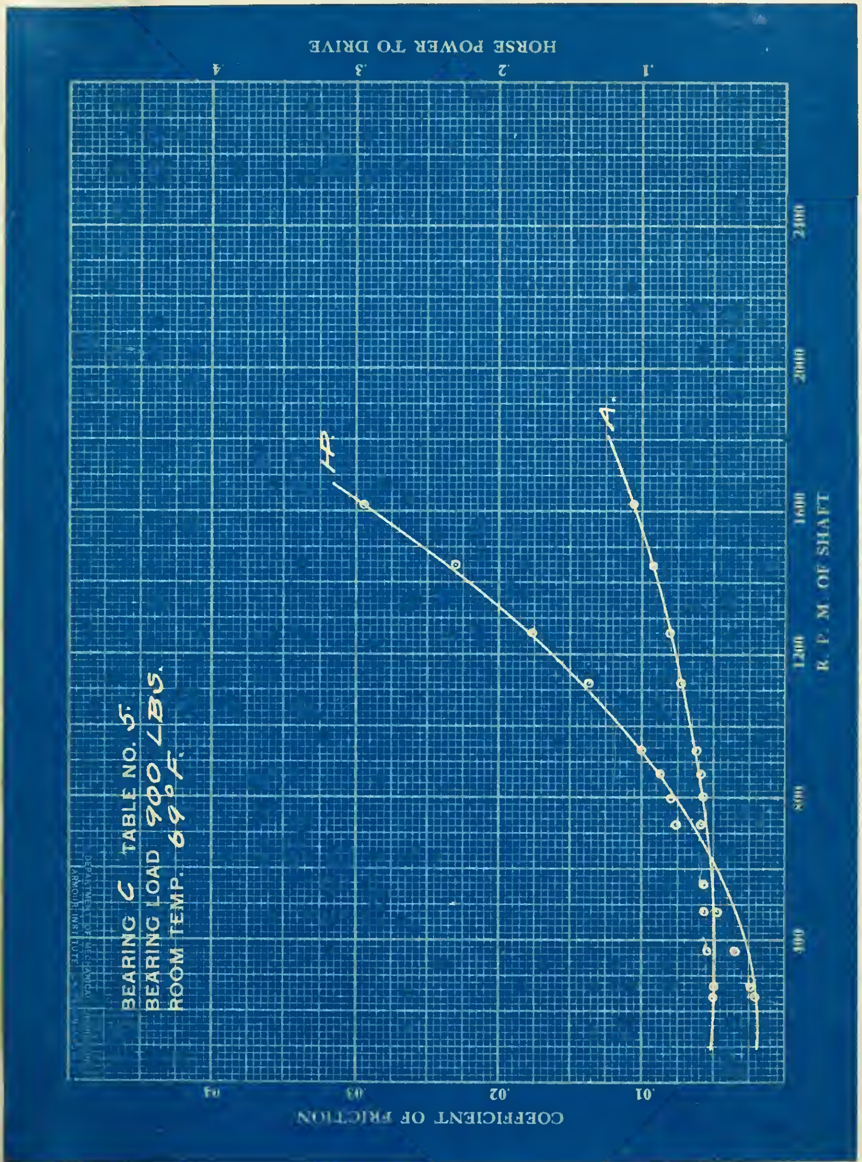
BEARING-C. TABLE NO.-1
BEARING LOAD -1500 LBS.
ROOM TEMP.-69° F.
H.P. TO DRIVE.
0.1
0.2
0.3
0.4
COEF. OF FRICTION
.01
.02
.03
.04
R.P.M. OF SHAFT
400
800
1200
1600
2000
2400

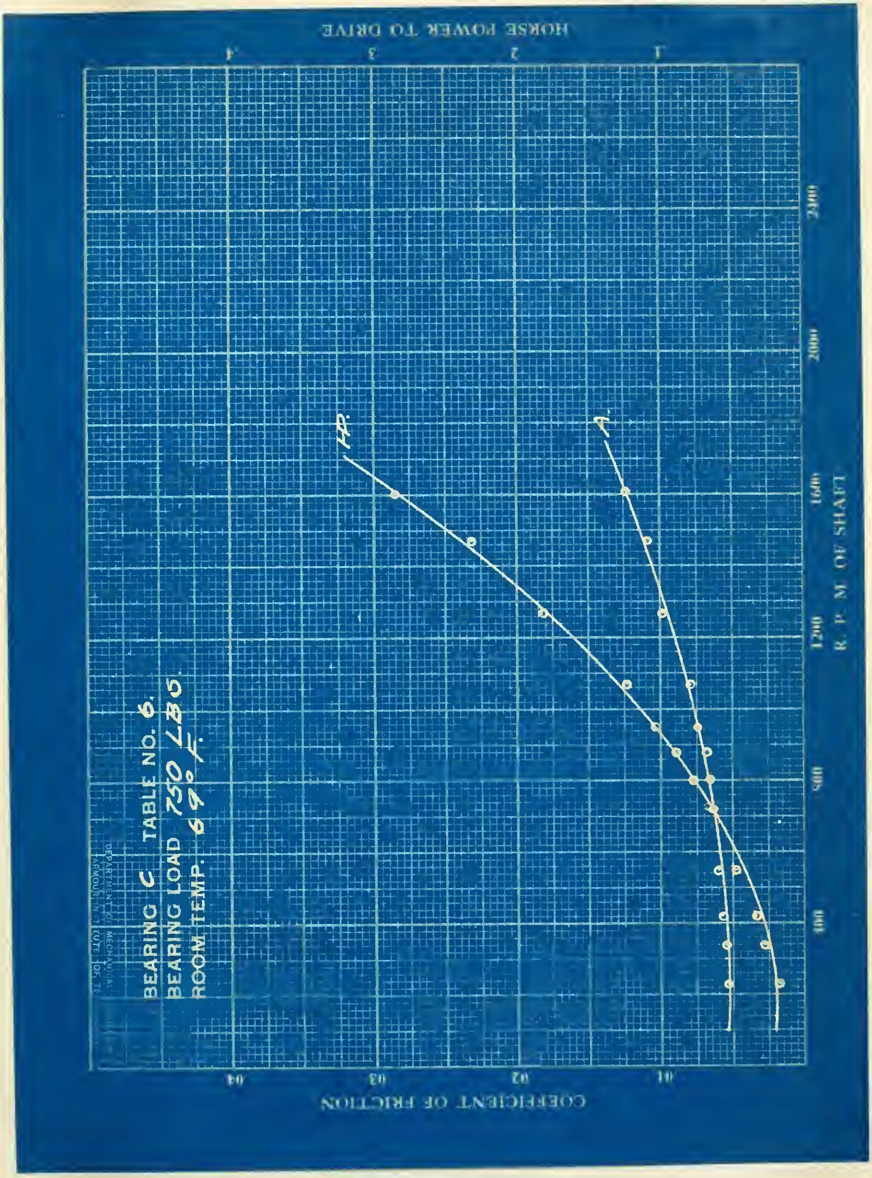

BEARING C TABLE NO. 2.
BEARING LOAD 1350 LBS.
ROOM TEMP. 69°F.
HORSE POWER TO DRIVE
1
2
3
4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
H
A.

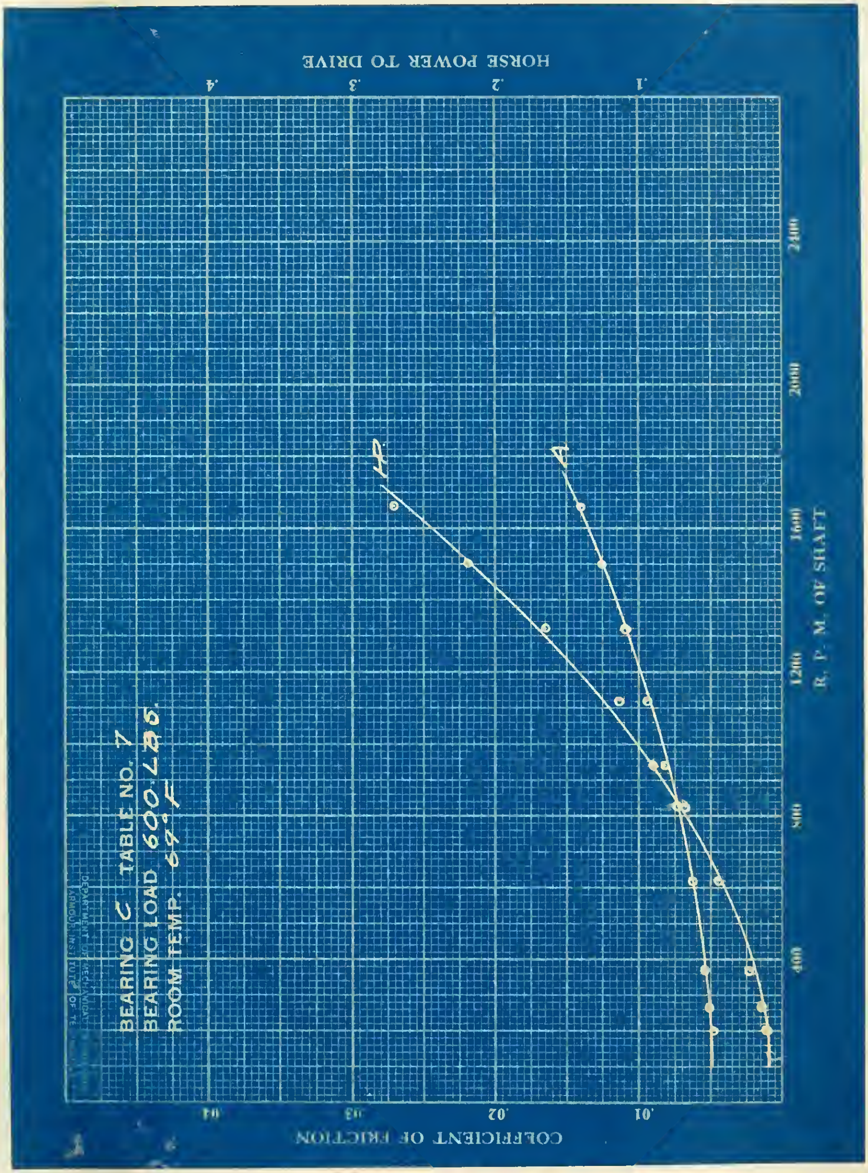

BEARING C TABLE NO. 3
BEARING LOAD 1200 LBS.
ROOM TEMP. 69° F.
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
HP
F

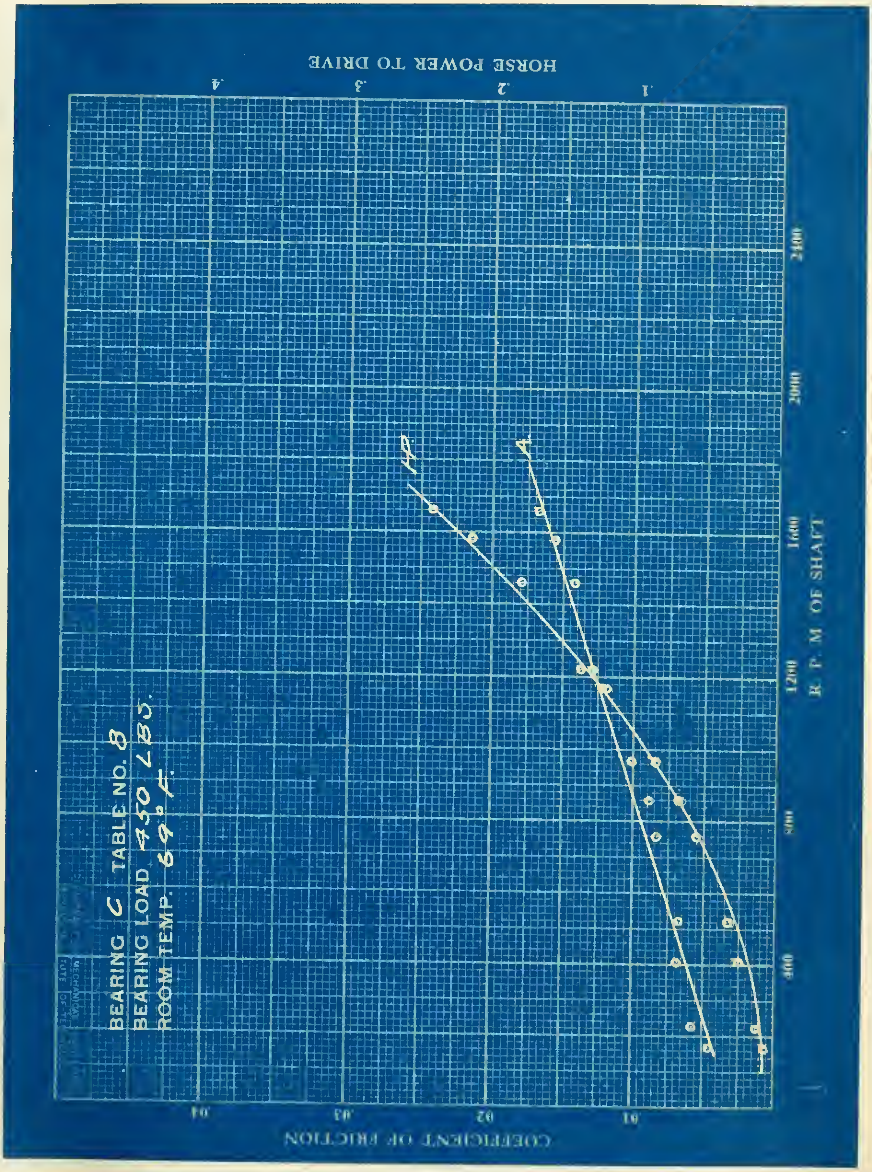


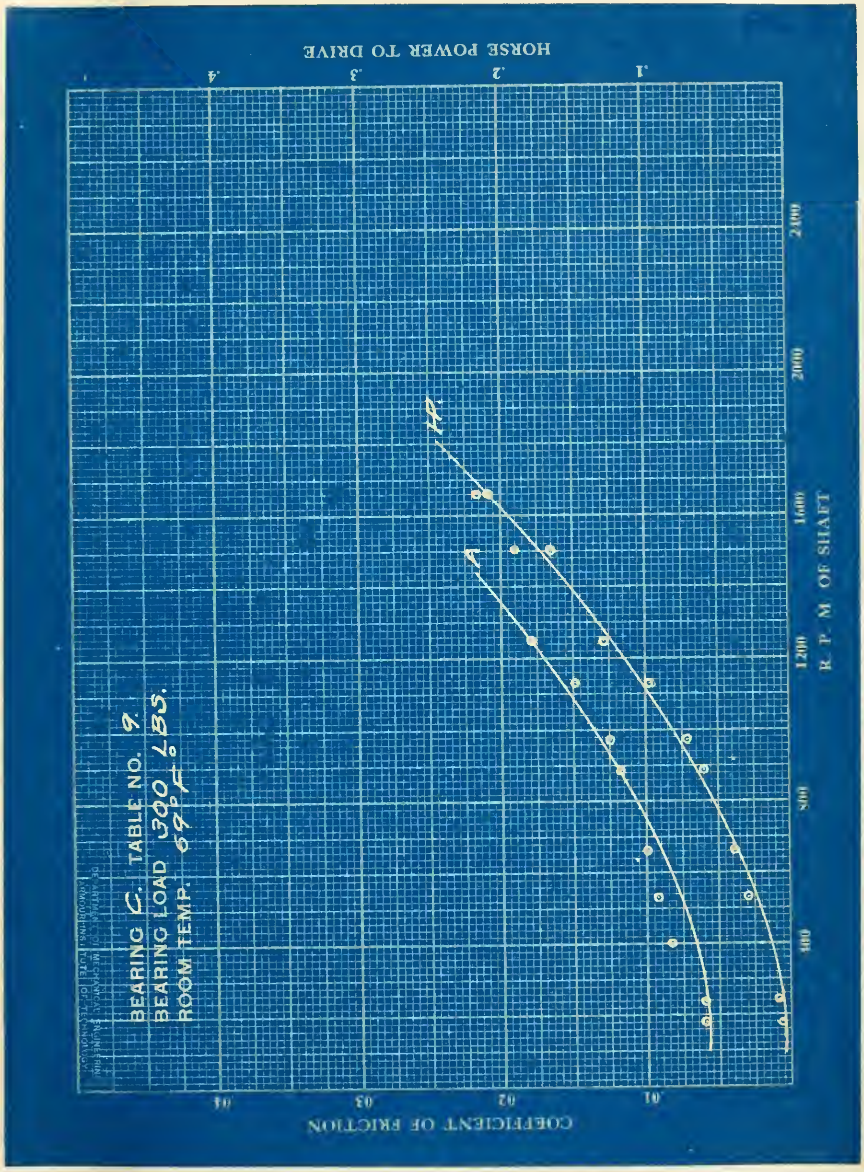
BEARING C TABLE NO. 4.
BEARING LOAD 1050 LBS.
ROOM TEMP. 69°F.
DEPARTMENT OF MECHANICAL ENGINEERING
ARMOUR INSTITUTE OF TECHNOLOGY
HORSE POWER TO DRIVE
1
2
3
4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
HP
f

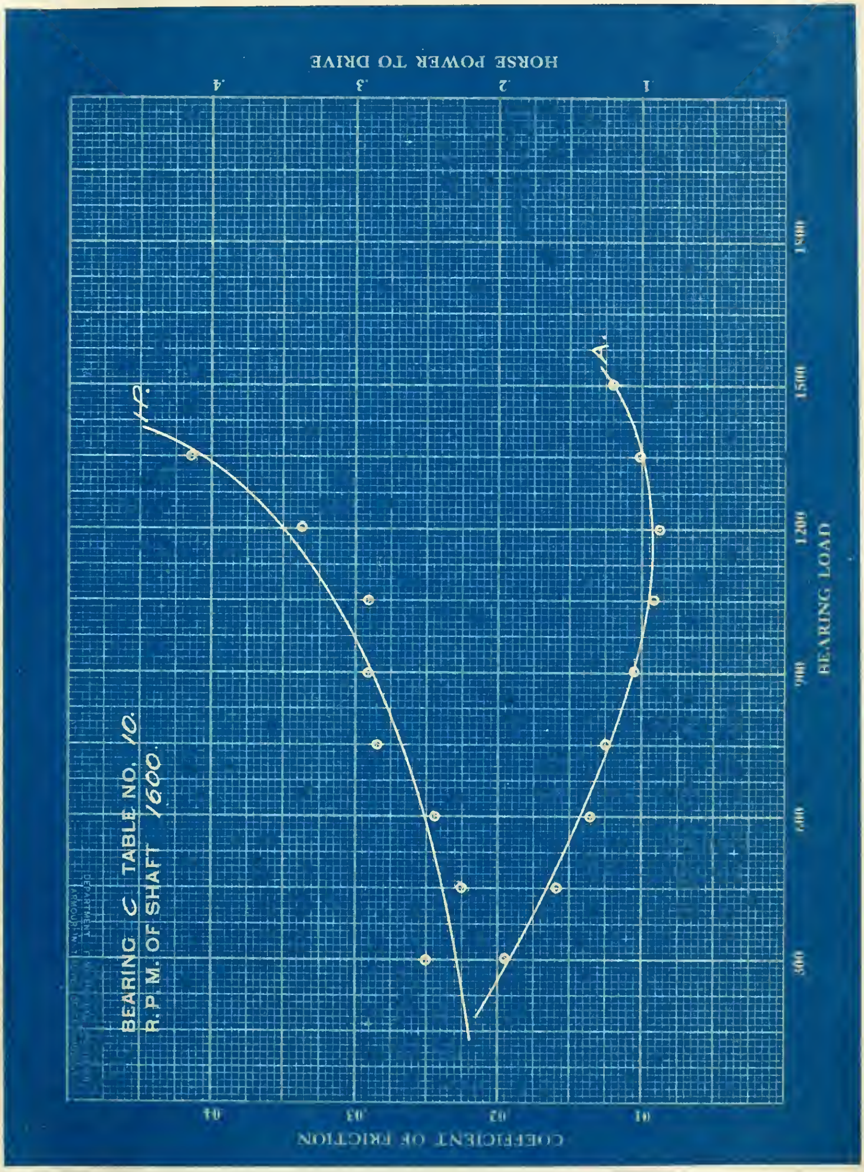

BEARING C TABLE NO. 5.
BEARING LOAD 900 LBS.
ROOM TEMP. 69°F.
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
HP.
A.
DEPARTMENT OF MECHANICAL
ARMOUR INSTITUTE

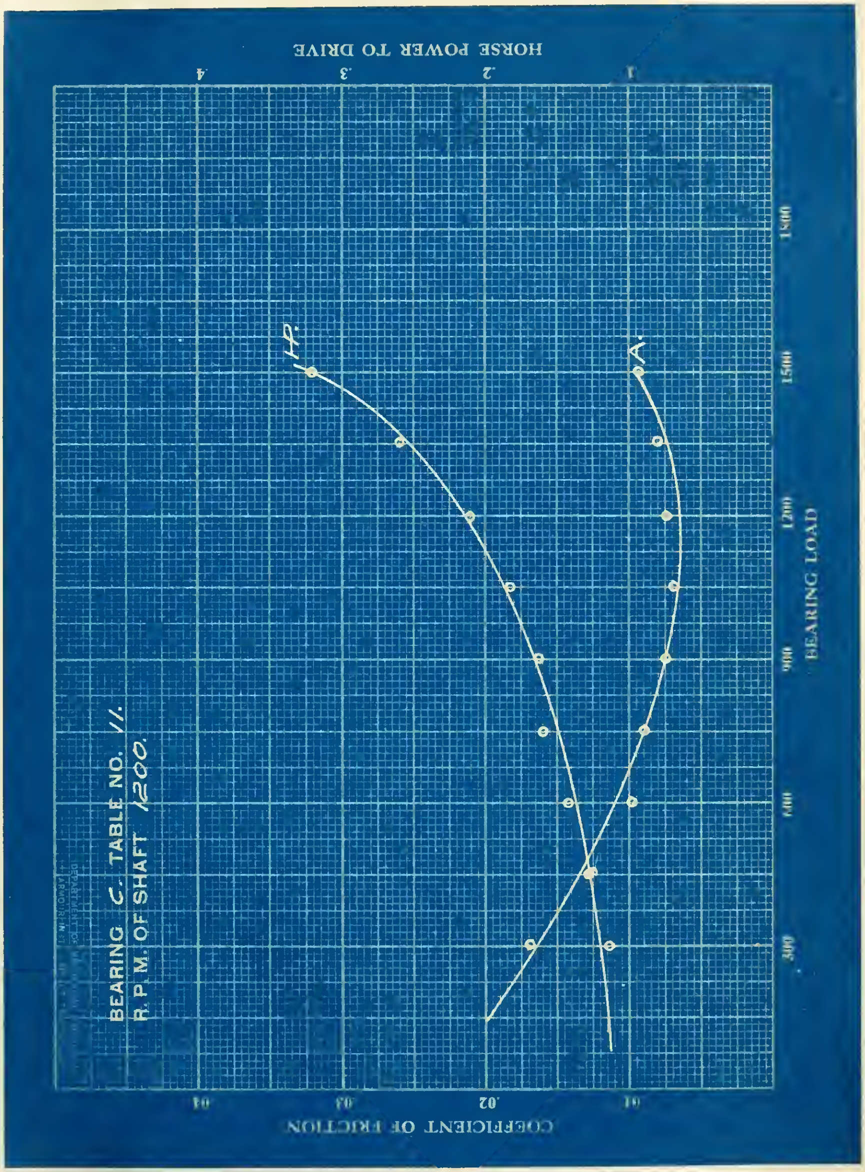

BEARING C TABLE NO. 6.
BEARING LOAD 750 LBS.
ROOM TEMP. 69° F.
HORSE POWER TO DRIVE
COEFFICIENT OF FRICTION
R. P. M. OF SHAFT
H.P.
f.

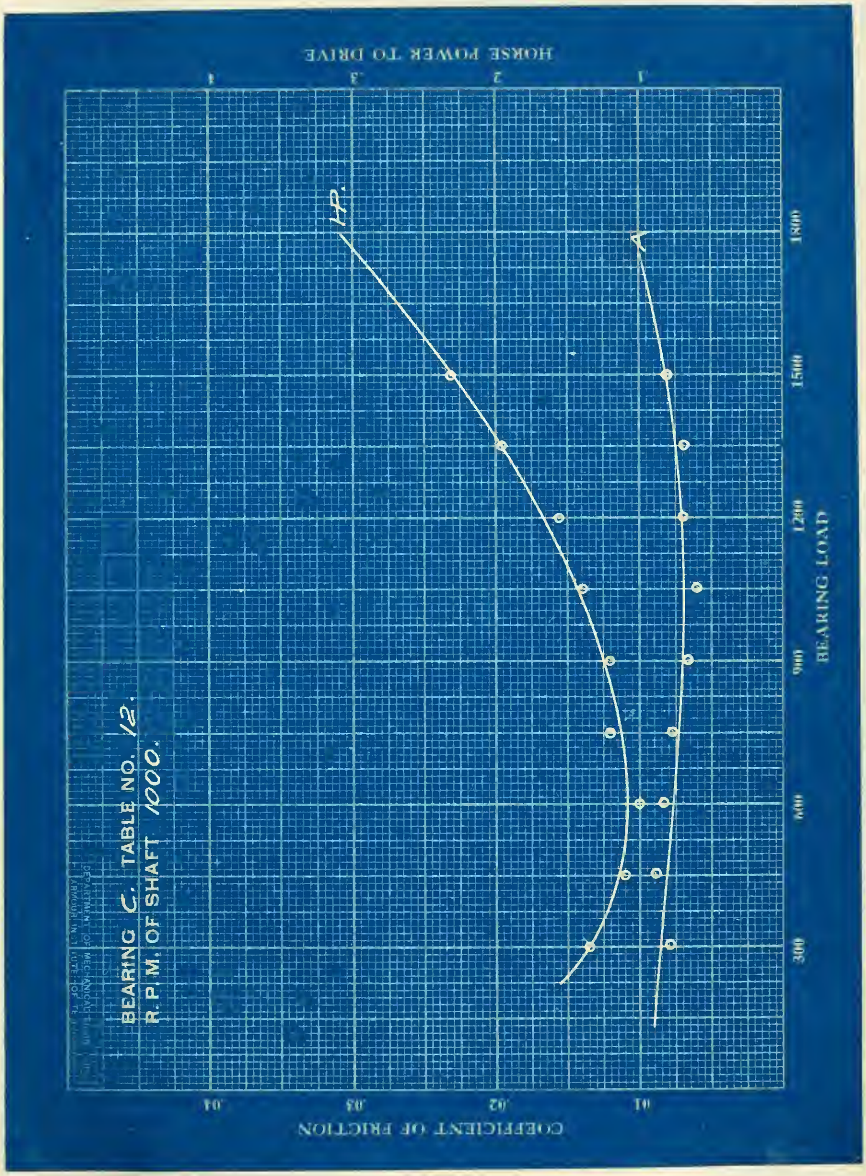

BEARING C TABLE NO. 7
BEARING LOAD 600 LBS.
ROOM TEMP. 69° F
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
HP
A

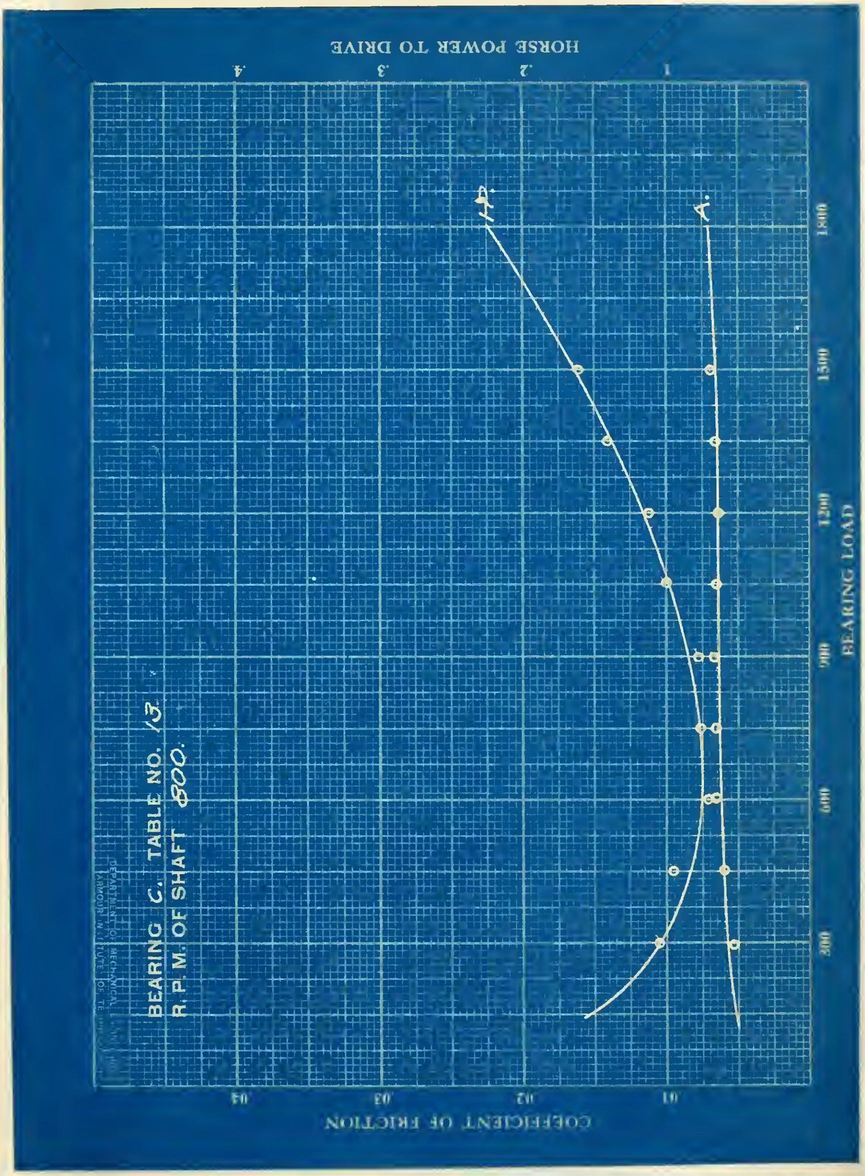

BEARING C TABLE NO. 8
BEARING LOAD 450 LBS.
ROOM TEMP. 69° F.
HORSE POWER TO DRIVE
.1
.2
.3
.4
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
COEFFICIENT OF FRICTION
.01
.02
.03
.04

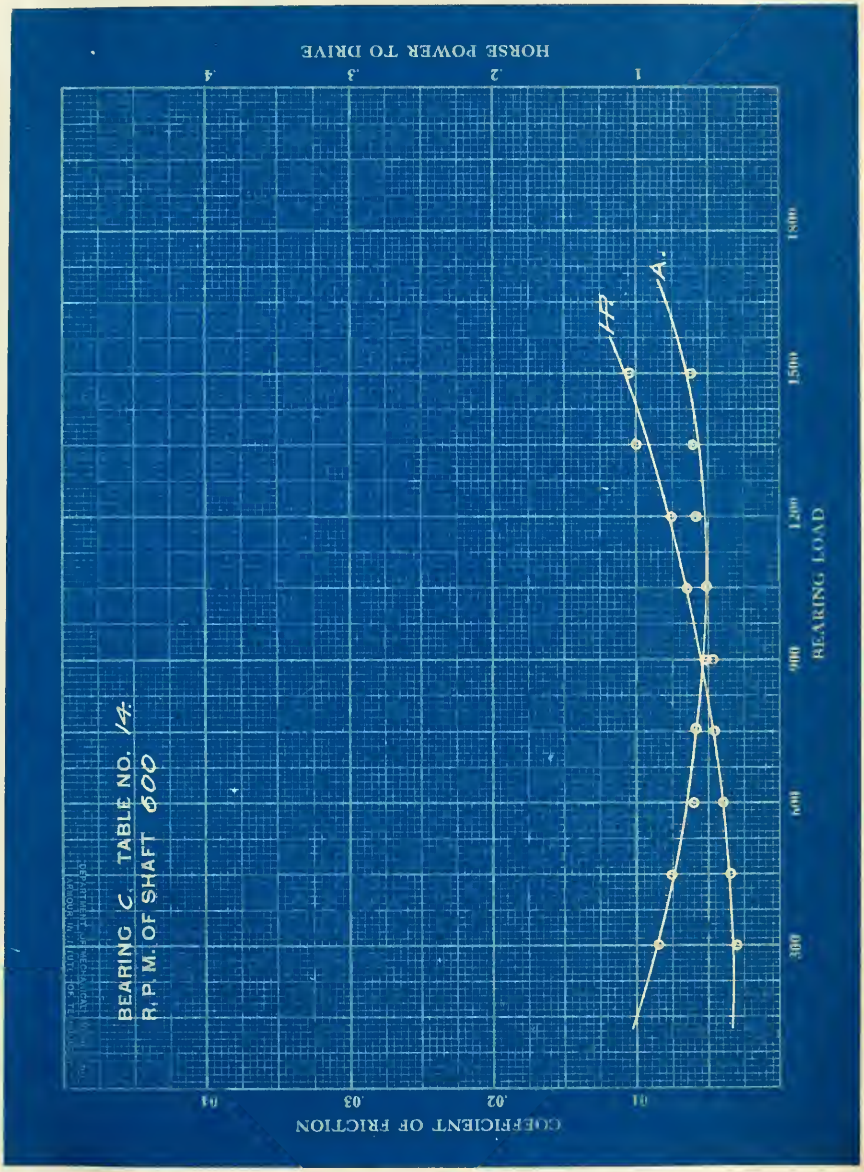

BEARING C. TABLE NO. 9.
BEARING LOAD 300 LBS.
ROOM TEMP. 69° F
DEPARTMENT OF MECHANICAL ENGINEERING
ARMOUR INSTITUTE OF TECHNOLOGY
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M OF SHAFT
400
800
1200
1600
2000
2400
HP

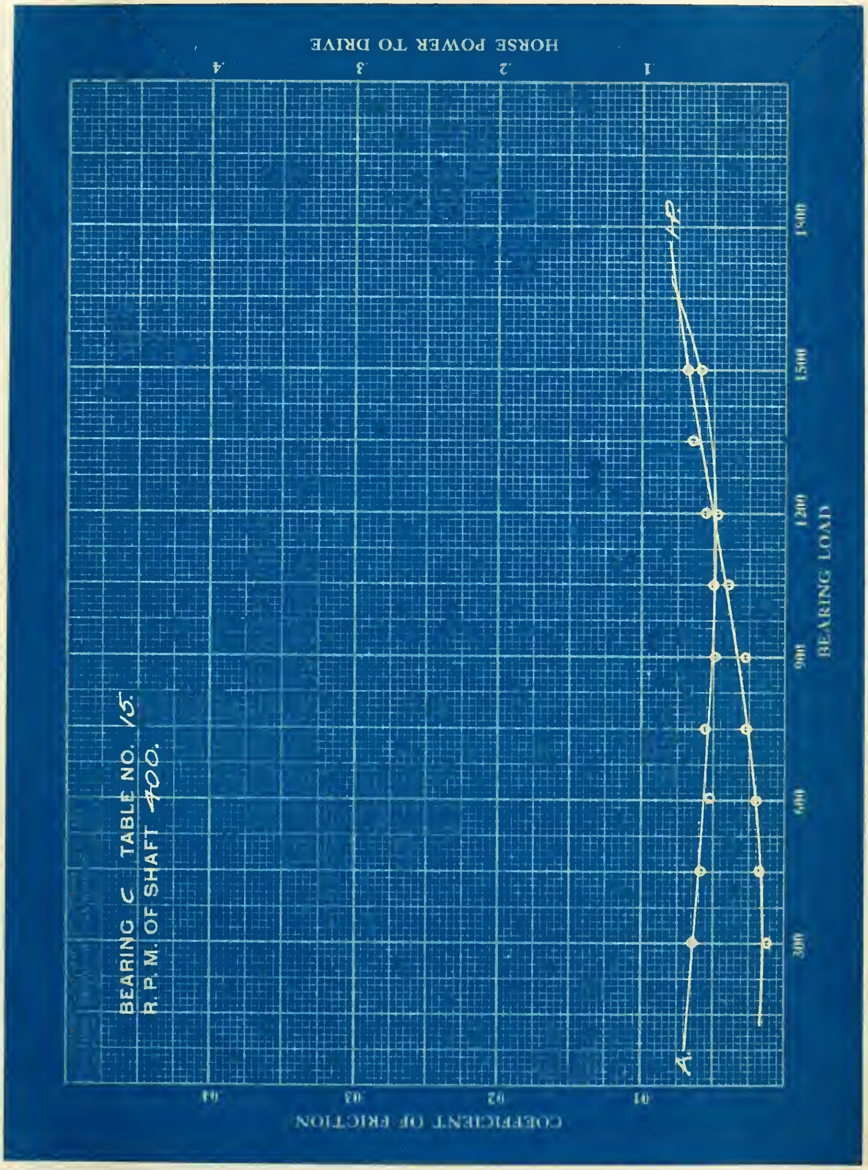

BEARING C TABLE NO. 10.
R.P.M. OF SHAFT 1600.
HORSE POWER TO DRIVE
COEFFICIENT OF FRICTION
BEARING LOAD
H.P.
A.

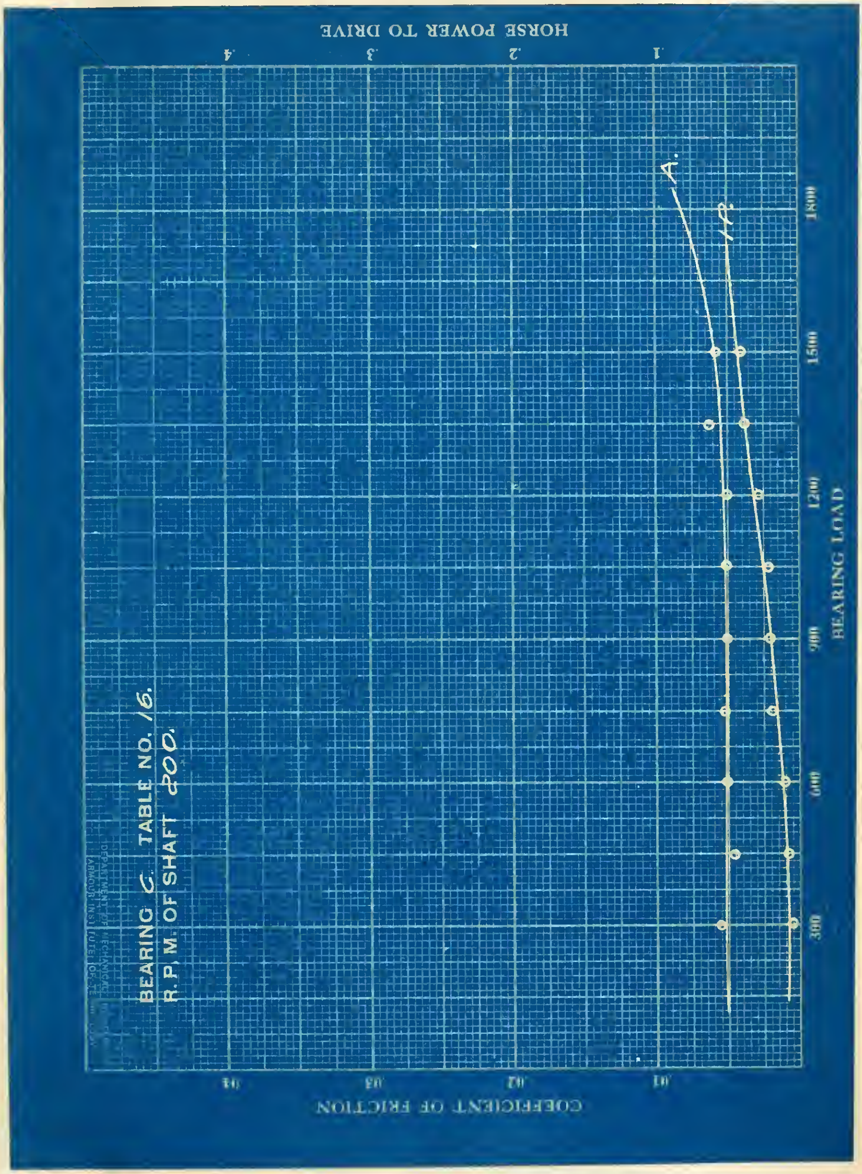

BEARING C. TABLE NO. 11.
R. P. M. OF SHAFT 1200.
HORSE POWER TO DRIVE
COEFFICIENT OF FRICTION
BEARING LOAD
H.P.
A.


BEARING C. TABLE NO. 12.
R.P.M. OF SHAFT 1000.
HORSE POWER TO DRIVE
1
2
3
4
H.P.
A
300
600
900
1200
1500
1800
BEARING LOAD
.01
.02
.03
.04
COEFFICIENT OF FRICTION


BEARING C. TABLE NO. 13
R.P.M. OF SHAFT 800.
HORSE POWER TO DRIVE
COEFFICIENT OF FRICTION
BEARING LOAD
A.
A.


BEARING C. TABLE NO. 14.
R.P.M. OF SHAFT 600
HORSE POWER TO DRIVE
COEFFICIENT OF FRICTION
BEARING LOAD
14
A.
300
600
900
1200
1500
1800
.1
.2
.3
.4
.01
.02
.03
.04


BEARING C. TABLE NO. 15.
R. P. M. OF SHAFT 400.
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
BEARING LOAD
300
600
900
1200
1500
1800
A.
HP


BEARING C. TABLE NO. 16.
R.P.M. OF SHAFT 200.
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
BEARING LOAD
300
600
900
1200
1500
1800
A.
H.P.

BEARING "D"

Fig. 11

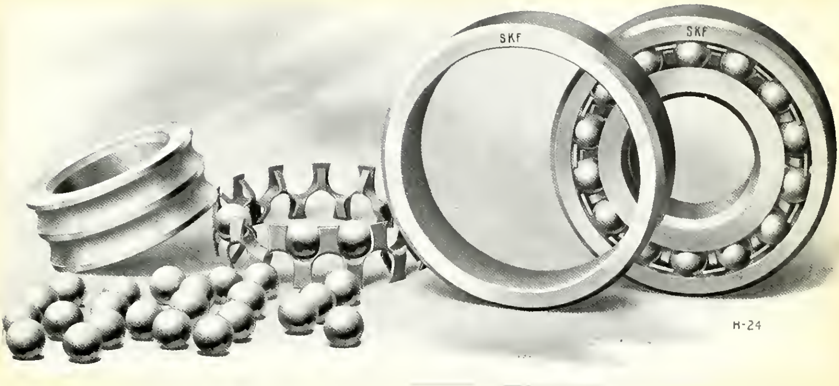


Fig. 12

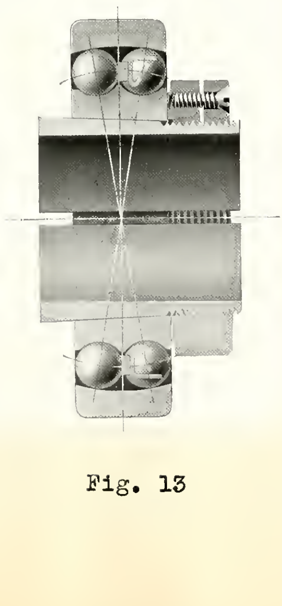


Fig. 13

BEARING "D"

Bearing "D", (Figures 11,12,13), is a self aligning adapter type radial ball bearing. The bearing consists of an outer ball race, an inner ball race, two rows of balls, a retainer for properly spacing and retaining the balls between the raceways and a housing for the whole.

The inner race contains two grooves, each ground to a radius slightly larger than the radius of the balls, while the outer race is ground in the form of a hollow sphere, whose center is the center of the axis of rotation. The balls, the retainer and inner race are free to rotate at any angle within the outer race and will adjust themselves to any possible degree of deflection of the shaft without binding either the balls or raceways.

The balls roll on the surface of the spherically ground outer ball race with a pure rolling motion without sliding friction.

This action is facilitated by the distribution of the load over a large number of balls.

These bearings were found to be highly efficient both in coefficient of friction and horse power to drive, and the reasons for this are plentiful. The friction in a ball bearing is independent of the viscosity of the lubricant or its temperature; the frictional resistance of starting and slow motion is very low. Another advantage it has is that it is more compact.

This type of bearing permits of the use of more balls per bearing, because, the two rows of balls are held in staggered relation by the retainer. This increases the carrying capacity of the bearing. The retainer is made of one piece and it is open at the sides permitting easy cleaning and positive lubrication.

The bearings were found to run absolutely cool at any load and speed and very economical, but, upon taking the bearings apart after the

test, it was seen that the ball races had become slightly grooved because of the load. This immediately decreases the efficiency of the bearing, because, there then is an area of contact instead of a point contact.

TABLES 1 - 16

of

BEARING "D"

to

BEARING D

Table No. 1 Date July 14th, 1915.

Bearing Load, LBS. 1500 Time, beginning of run 9:25 A.M.

Room Temp.° Fahr. 74 Time, end of run

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.145	2023	4.57	0.147	0.00249	0.00148
0.125	1832	3.94	0.114	0.00215	0.00129
0.11	1546	3.46	0.085	0.00189	0.00113
0.105	1354	3.31	0.071	0.00181	0.00108
0.09	1114	2.84	0.050	0.00155	0.00092
0.085	872	2.67	0.037	0.00146	0.00087
0.085	817	2.67	0.035	0.00146	0.00087
0.08	636	2.52	0.025	0.00138	0.00082
0.07	496	2.20	0.017	0.00121	0.00072
0.065	284	2.05	0.0092	0.00112	0.00067
0.06	130	1.89	0.0039	0.00103	0.00061

Remarks:—

[illegible]

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

BEARING D

Table No. 2 Date July 14th, 1915.

Bearing Load, LBS. 1350 Time, beginning of run

Room Temp.° Fahr. 74 Time, end of run

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.115	2120	3.62	0.122	0.00221	0.00132
0.10	2003	3.15	0.100	0.00192	0.00114
0.09	1784	2.84	0.080	0.00173	0.00103
0.085	1570	2.67	0.0667	0.00163	0.00097
0.085	1218	2.67	0.0517	0.00163	0.00097
0.085	1115	2.67	0.0473	0.00163	0.00097
0.08	057	2.52	0.0382	0.00154	0.00083
0.075	857	2.36	0.0321	0.00144	0.00086
0.07	730	2.20	0.0255	0.00134	0.00080
0.065	591	2.05	0.0192	0.00125	0.60075
0.06	431	1.88	0.0129	0.00115	0.00069
0.055	316	1.73	0.0087	0.00105	0.00063
0.05	205	1.57	0.0051	0.00096	0.00057

Remarks:— Collar friction eased up at beginning of run.

BEARING D

Table No. 3 Date July 14th, 1915.

Bearing Load, LBS. 1200 Time, beginning of run 10:03 A.M.

Room Temp.° Fahr. 74 Time, end of run 10:21 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.095	2205	2.99	0.1045	0.00205	0.00122
0.085	1963	2.67	0.0835	0.00183	0.00109
0.08	1753	2.52	0.0702	0.00173	0.00103
0.08	1477	2.52	0.0590	0.00173	0.00103
0.075	1380	2.30	0.0518	0.00162	0.00097
0.075	1127	2.39	0.0422	0.00162	0.00097
0.07	975	2.20	0.0342	0.00151	0.00090
0.065	882	2.05	0.0286	0.00141	0.00084
0.06	831	1.89	0.0249	0.00129	0.00077
0.055	659	1.73	0.0181	0.00119	0.00071
0.055	498	1.73	0.0137	0.00119	0.00071
0.05	329	1.57	0.0082	0.00108	0.00064
0.04	125	1.26	0.0025	0.00086	0.00051

Remarks:—

BEARING D

Table No. 4 Date July 14th, 1915.

Bearing Load, LBS. 1050 Time, beginning of run 10:21 A.M.

Room Temp.° Fahr. 74 Time, end of run

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.095	2260	2.99	0.1073	0.00234	0.00139
0.09	2034	2.83	0.0915	0.00221	0.00131
0.085	1768	2.67	0.0952	0.00209	0.00125
0.075	1572	2.36	0.0590	0.00184	0.00110
0.07	1385	2.20	0.0485	0.00172	0.00102
0.07	1125	2.20	0.0395	0.00172	0.00102
0.07	974	2.20	0.0341	0.00172	0.00102
0.065	869	2.05	0.0282	0.00160	0.00095
0.06	747	1.89	0.0224	0.00148	0.00088
0.055	590	1.73	0.0162	0.00136	0.00081
0.045	342	1.42	0.0077	0.00111	0.00066
0.035	146	1.10	0.0026	0.00086	0.00051

Remarks:—

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BEARING D

Table No. 5 Date July 14th, 1915.

Bearing Load, LBS. 900 Time, beginning of run

Room Temp.° Fahr. 74 Time, end of run

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.09	2272	2.84	0.1022	0.00259	0.00155
0.085	1994	2.67	0.0847	0.00244	0.00146
0.08	1722	2.52	0.0690	0.00230	0.00137
0.07	1505	2.20	0.0537	0.00205	0.00122
0.065	1272	2.05	0.0414	0.00187	0.00111
0.065	1158	2.05	0.0377	0.00187	0.00111
0.065	964	2.05	0.0314	0.00187	0.00111
0.065	902	2.05	0.0292	0.00187	0.00111
0.055	804	1.73	0.0221	0.00158	0.00094
0.045	618	1.42	0.0139	0.00130	0.00078
0.035	328	1.10	0.0058	0.00100	0.00060
0.03	125	0.95	0.0019	0.00087	0.00057

Remarks:—

[illegible]

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BEARING D

Table No. 6 Date July 14th, 1915.

Bearing Load, LBS. 750 Time, beginning of run

Room Temp.° Fahr. 74 Time, end of run 11:04 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.085	2307	2.67	0.0981	0.00292	0.00174
0.075	2053	2.36	0.0770	0.00258	0.00154
0.065	1761	2.05	0.0573	0.00224	0.00134
0.06	1601	1.89	0.0483	0.00207	0.00124
0.055	1274	1.73	0.0350	0.00189	0.00113
0.055	1157	1.73	0.0318	0.00189	0.00113
0.055	983	1.73	0.0270	0.00189	0.00113
0.05	876	1.58	0.0219	0.00173	0.00103
0.045	788	1.42	0.0178	0.00156	0.00093
0.04	616	1.26	0.0123	0.00138	0.00082
0.35	445	1.10	0.0078	0.00120	0.00072
0.025	210	0.79	0.0026	0.00087	0.00057

Remarks:—

[illegible]

[illegible]

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

BEARING D

Table No. 7 Date July 14th, 1915.

Bearing Load, LBS. 600 Time, beginning of run 11:04 A.M.

Room Temp.° Fahr. 74 Time, end of run

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.08	2310	2.52	0.0925	0.00345	0.00206
0.07	2012	2.21	0.0705	0.00303	0.00187
0.06	1731	1.89	0.0519	0.00259	0.00155
0.055	1451	1.73	0.0400	0.00237	0.00141
0.05	1255	1.58	0.0314	0.00216	0.00129
0.05	1170	1.58	0.0293	0.00216	0.00129
0.05	1004	1.58	0.0251	0.00216	0.00129
0.045	936	1.42	0.0211	0.00194	0.00116
0.045	822	1.42	0.0185	0.00194	0.00116
0.04	700	1.26	0.0140	0.00172	0.00103
0.03	513	0.95	0.0077	0.00129	0.00077
0.03	350	0.95	0.0053	0.00129	0.00077
0.0225	150	0.71	0.0017	0.00097	0.00058

Remarks:—

BEARING D

Table No. 8 Date July 14th, 1915.

Bearing Load, LBS. 450 Time, beginning of run

Room Temp.° Fahr. 74 Time, end of run

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.075	2293	2.36	0.0860	0.00432	0.00251
0.065	2034	2.05	0.0661	0.00375	0.00223
0.055	1689	1.73	0.0464	0.00316	0.00188
0.05	1554	1.58	0.0388	0.00289	0.00172
0.05	1403	1.58	0.0351	0.00289	0.00172
0.045	1160	1.42	0.0261	0.00259	0.00154
0.045	986	1.42	0.0222	0.00259	0.00154
0.04	900	1.26	0.0180	0.00230	0.00137
0.04	837	1.26	0.0167	0.00230	0.00137
0.035	704	1.10	0.0123	0.00201	0.00120
0.025	333	0.79	0.0042	0.00141	0.00086
0.02	130	0.63	0.0013	0.00115	0.00069

Remarks:—

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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BEARING D

Table No. 9 Date July 14th,1915.

Bearing Load, LBS. 300 Time, beginning of run

Room Temp.° Fahr. 74 Time, end of run 12:00 M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.075	2400	2.36	0.0900	0.00647	0.00386
0.065	2184	2.05	0.0712	0.00563	0.00336
0.06	1924	1.89	0.0578	0.00519	0.00309
0.055	1687	1.73	0.0464	0.00475	0.00283
0.05	1594	1.58	0.0398	0.00433	0.00258
0.045	1264	1.42	0.0285	0.00390	0.00232
0.045	1117	1.42	0.0252	0.00390	0.00232
0.05	985	1.58	0.0246	0.00433	0.00258
0.055	876	1.73	0.0242	0.00475	0.00283
0.055	679	1.73	0.0187	0.00475	0.00283
0.05	483	1.58	0.0121	0.00433	0.00258
0.045	290	1.42	0.0065	0.00390	0.00232
0.04	151	1.26	0.0031	0.00346	0.00206
0.02	88	0.63	0.0009	0.00173	0.00103

Remarks:— Excessive collar friction during run.

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

DATA INTERPOLATED
FROM TABLES 1—9

Bearing D

R. P. M. of Shaft 2000

Table No. 10

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.145	0.0024	0.00155
1350	0.104	0.0022	0.0013
1200	0.092	0.0019	0.0011
1050	0.091	0.0023	0.0014
900	0.08	0.0025	0.0015
750	0.07	0.0025	0.0015
600	0.068	0.003	0.0017
450	0.06	0.0036	0.0025
300	0.06	0.0051	0.0033

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing D

R. P. M. of Shaft 1600

Table No. 11

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
1500	0.087	0.002	0.0012
1350	0.065	0.002	0.001
1200	0.065	0.0017	0.0009
1050	0.067	0.002	0.0012
900	0.051	0.002	0.0012
750	0.048	0.0021	0.0012
600	0.042	0.0025	0.0013
450	0.042	0.0028	0.0017
300	0.043	0.0041	0.0026

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing D

R. P. M. of Shaft 1200

Table No. 12

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
1500	0.056	0.0017	0.001
1350	0.043	0.0015	0.0009
1200	0.04	0.0015	0.0007
1050	0.044	0.0017	0.0009
900	0.031	0.0018	0.001
750	0.032	0.002	0.001
600	0.028	0.0022	0.0011
450	0.028	0.0024	0.0014
300	0.031	0.0038	0.0024

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing D

R. P. M. of Shaft 800

Table No. 13

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.035	0.0014	0.0007
1350	0.026	0.0013	0.0005
1200	0.02	0.0012	0.0005
1050	0.024	0.0015	0.0006
900	0.02	0.0015	0.0006
750	0.02	0.0019	0.0009
600	0.015	0.002	0.0009
450	0.016	0.002	0.0011
300	0.021	0.0047	0.0021

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing D

R. P. M. of Shaft 600

Table No. 14

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.024	0.0012	0.0005
1350	0.018	0.0011	0.0004
1200	0.012	0.001	0.0004
1050	0.015	0.0013	0.0005
900	0.015	0.0014	0.0005
750	0.015	0.0016	0.0008
600	0.011	0.0018	0.0008
450	0.01	0.0019	0.0010
300	0.017	0.005	0.0032

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing D

R. P. M. of Shaft 400

Table No. 15

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.014	0.001	0.0005
1350	0.011	0.001	0.0003
1200	0.007	0.001	0.0003
1050	0.008	0.0011	0.0004
900	0.01	0.001	0.0004
750	0.008	0.0015	0.0006
600	0.005	0.0015	0.0004
450	0.006	0.0016	0.0010
300	0.012	0.0045	0.0028

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing D

R. P. M. of Shaft 200

Table No. 16

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.007	0.001	0.0004
1350	0.004	0.001	0.0003
1200	0.004	0.001	0.0003
1050	0.004	0.001	0.0003
900	0.004	0.001	0.0003
750	0.003	0.0009	0.0002
600	0.003	0.0009	0.0002
450	0.002	0.0013	0.0008
300	0.007	0.003	0.002

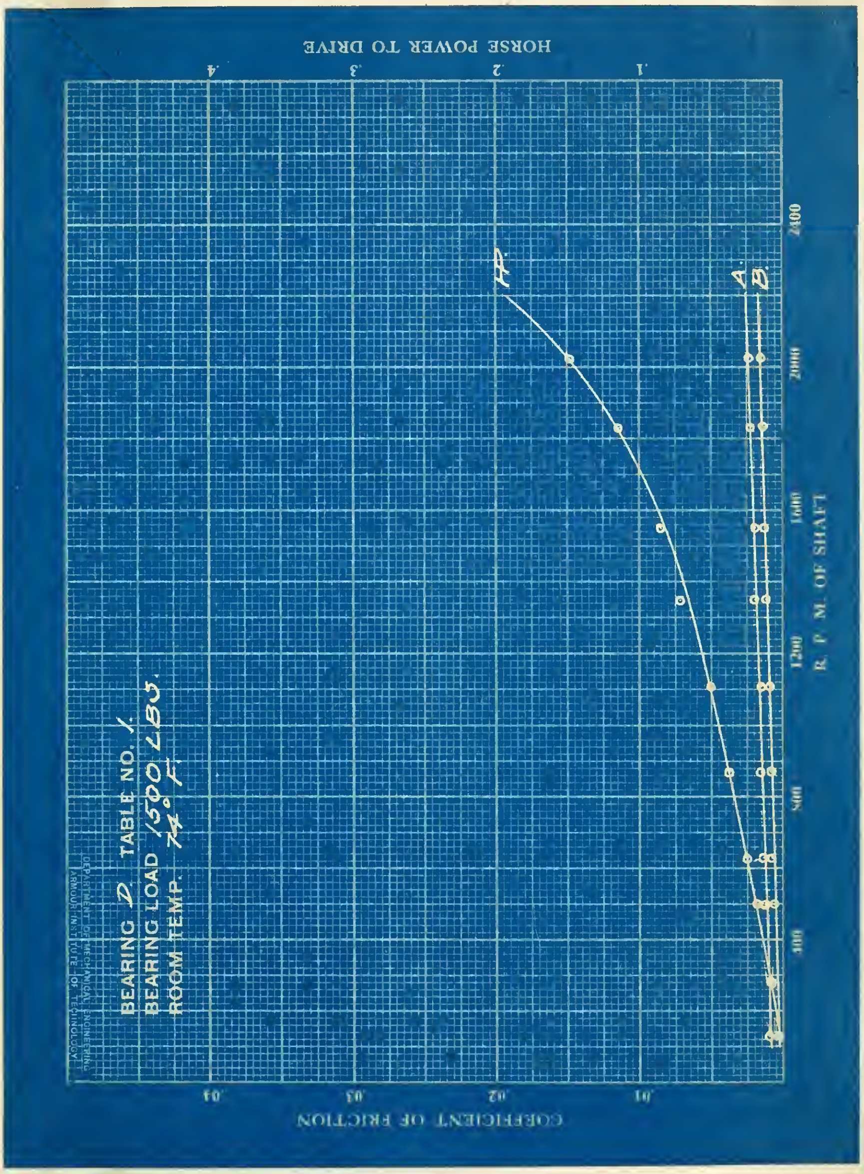
Remarks:—

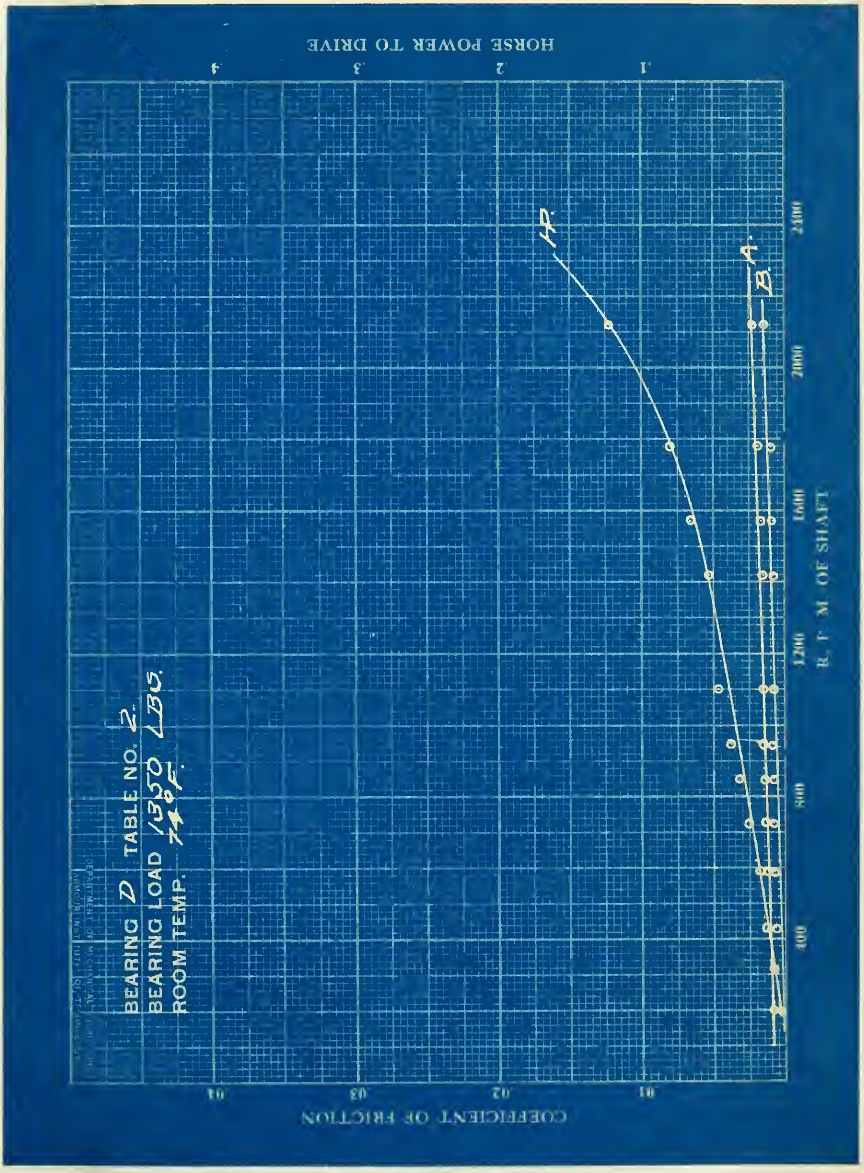
CURVES PLOTTED FROM

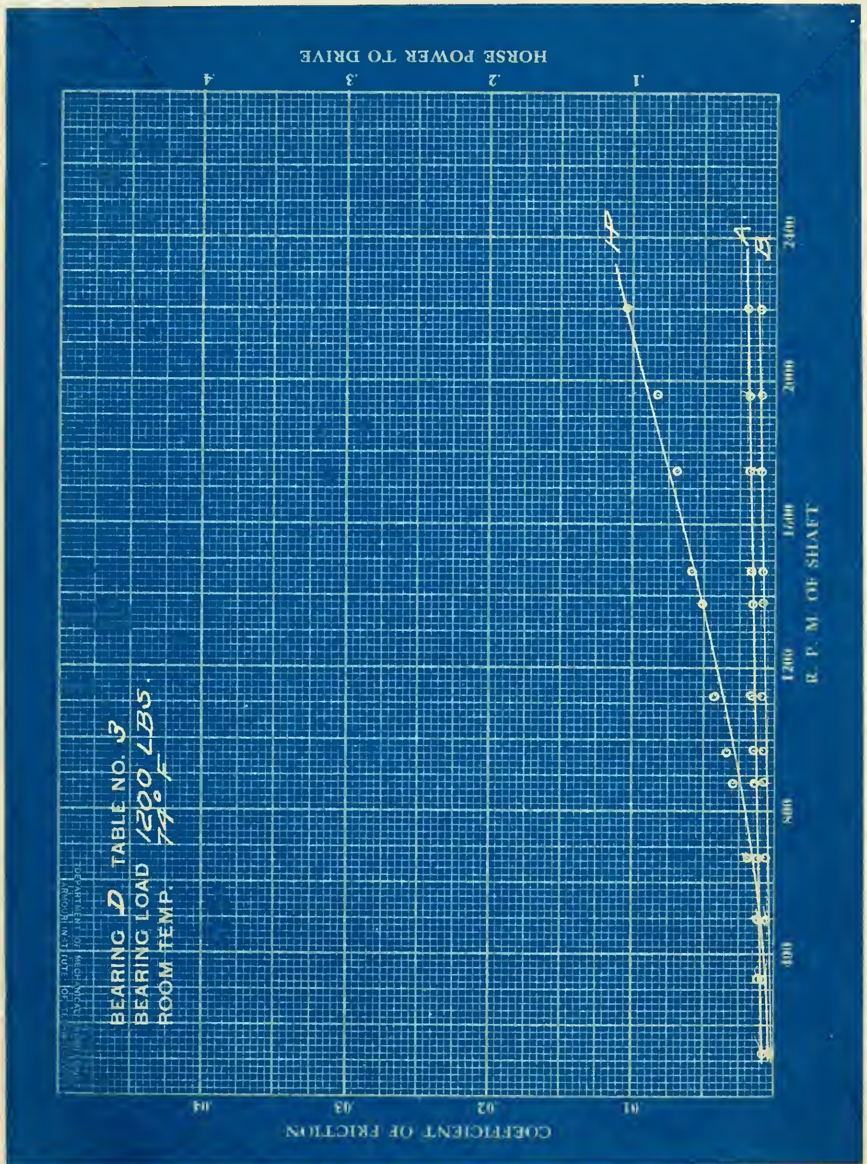
TABLES 1 - 16

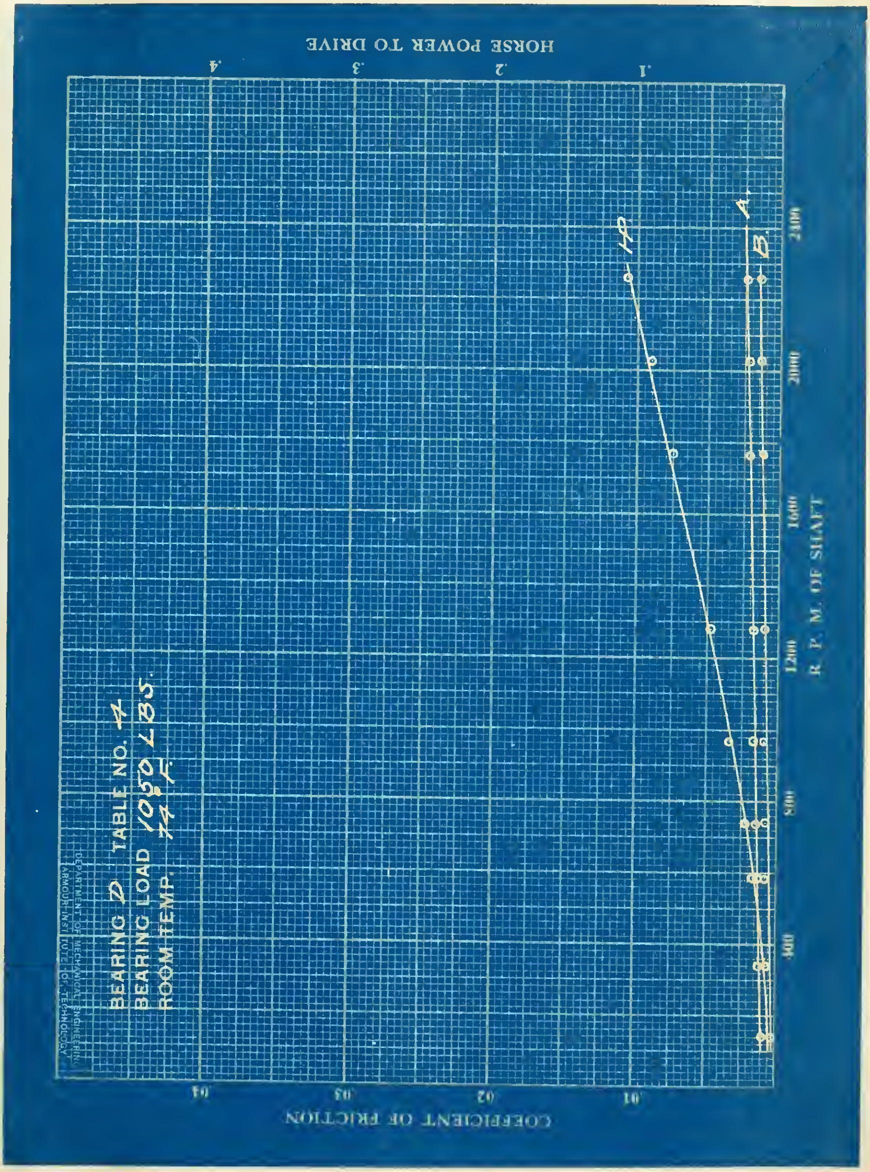
OF

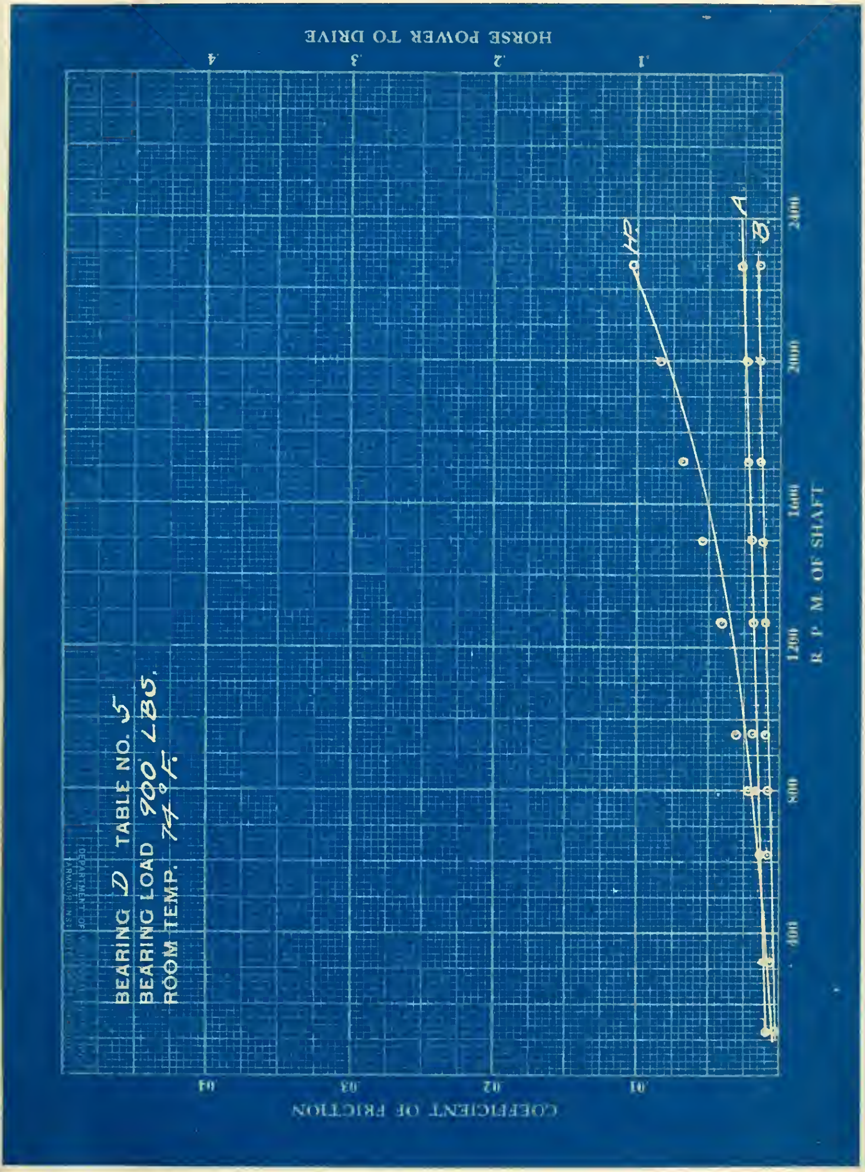
BEARING "D"

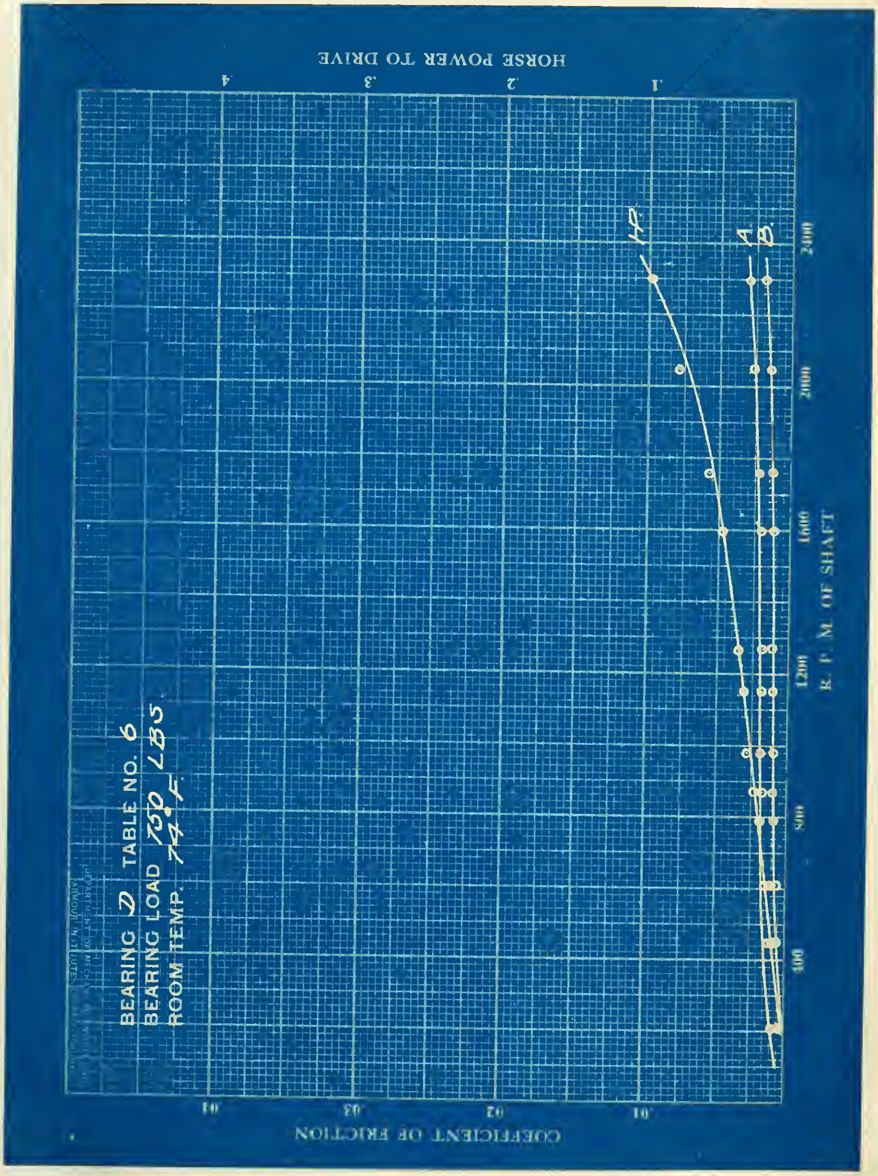

BEARING D TABLE NO. 1
BEARING LOAD 1500 LBS.
ROOM TEMP. 74° F.
DEPARTMENT OF MECHANICAL ENGINEERING
ARMOUR INSTITUTE OF TECHNOLOGY
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
H.P.
A.
B.

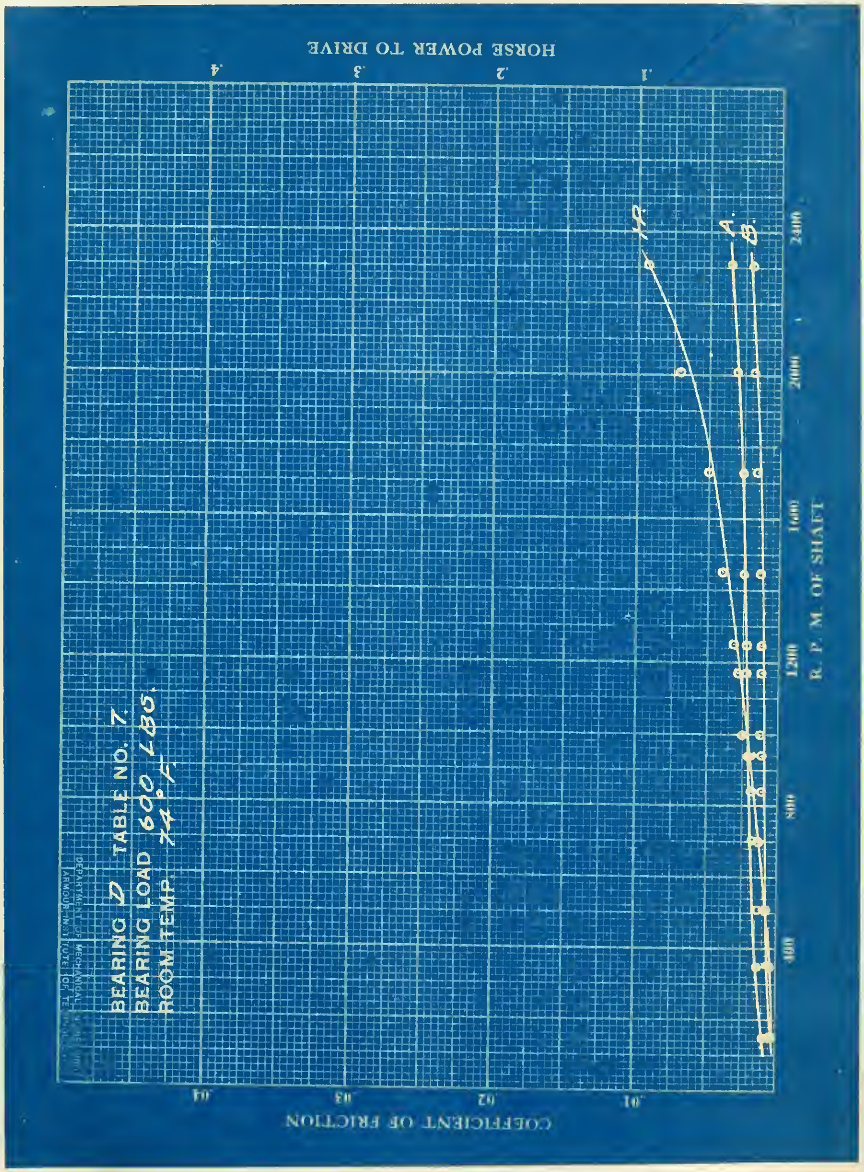

BEARING D TABLE NO. 2.
BEARING LOAD 1350 LBS.
ROOM TEMP. 74°F.
HORSE POWER TO DRIVE
COEFFICIENT OF FRICTION
R. P. M. OF SHAFT
HP
A
B

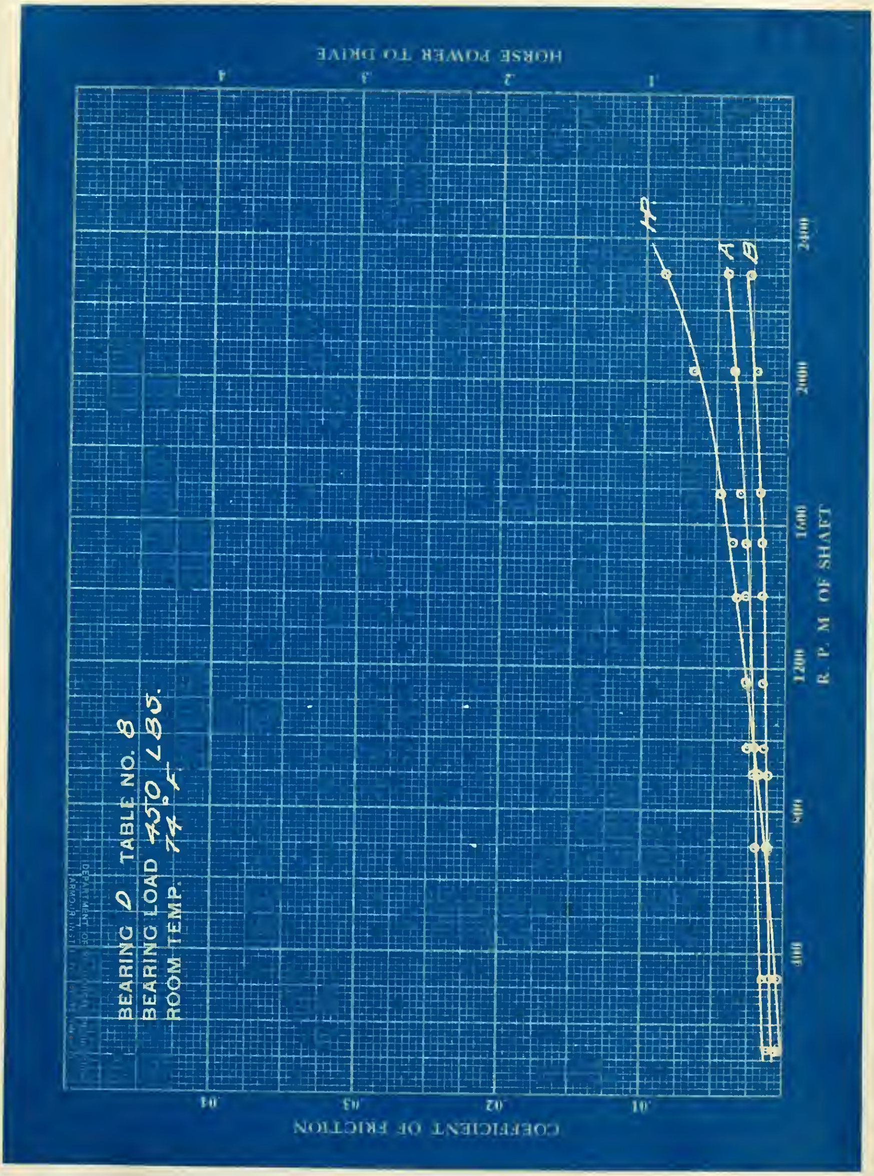

BEARING D TABLE NO. 3
BEARING LOAD 1200 LBS.
ROOM TEMP. 74° F
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
HP
A
B

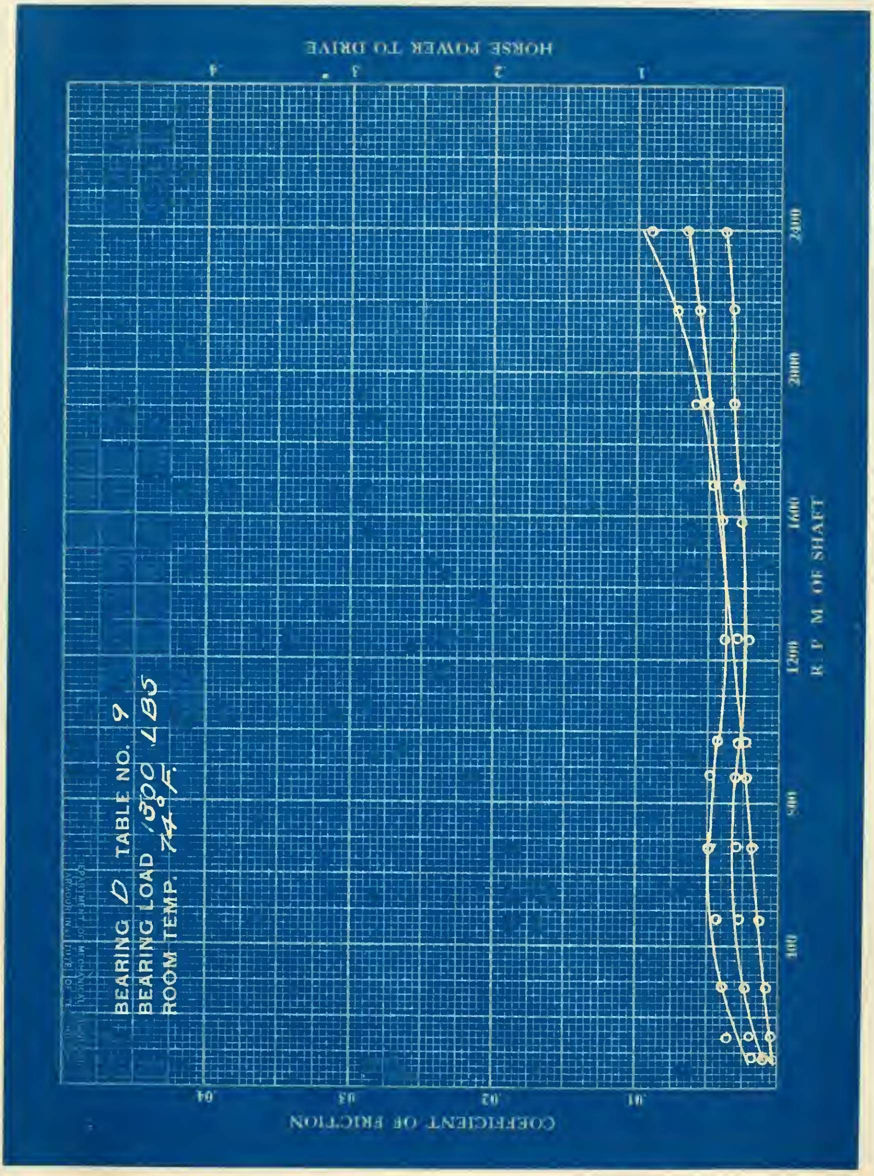

BEARING D TABLE NO. 4
BEARING LOAD 1050 LBS.
ROOM TEMP. 74 F.
DEPARTMENT OF MECHANICAL ENGINEERING
ARMOUR INSTITUTE OF TECHNOLOGY
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
HP
A
B


BEARING D TABLE NO. 5
BEARING LOAD 900 LBS.
ROOM TEMP. 74°F.
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
HP
A
B

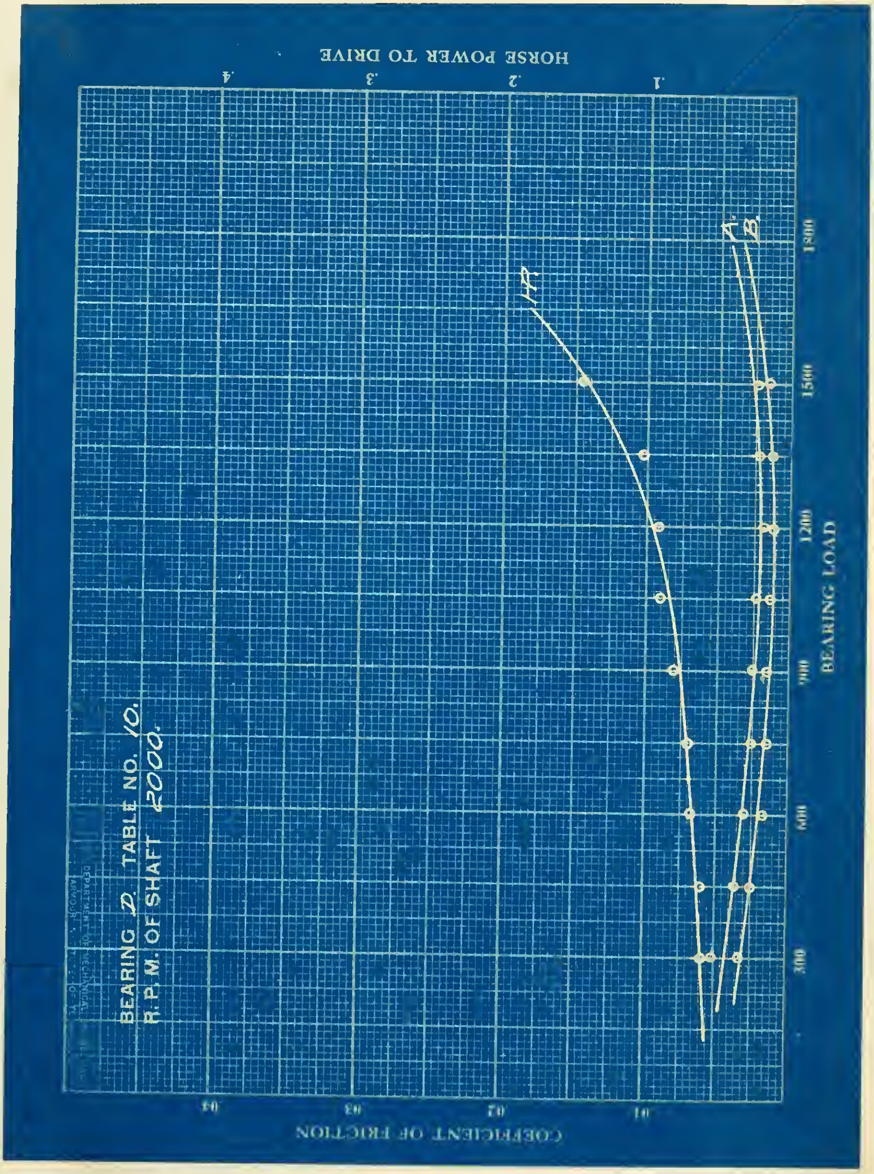

BEARING D TABLE NO. 6
BEARING LOAD 750 LBS
ROOM TEMP. 74° F
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
HP
A
B

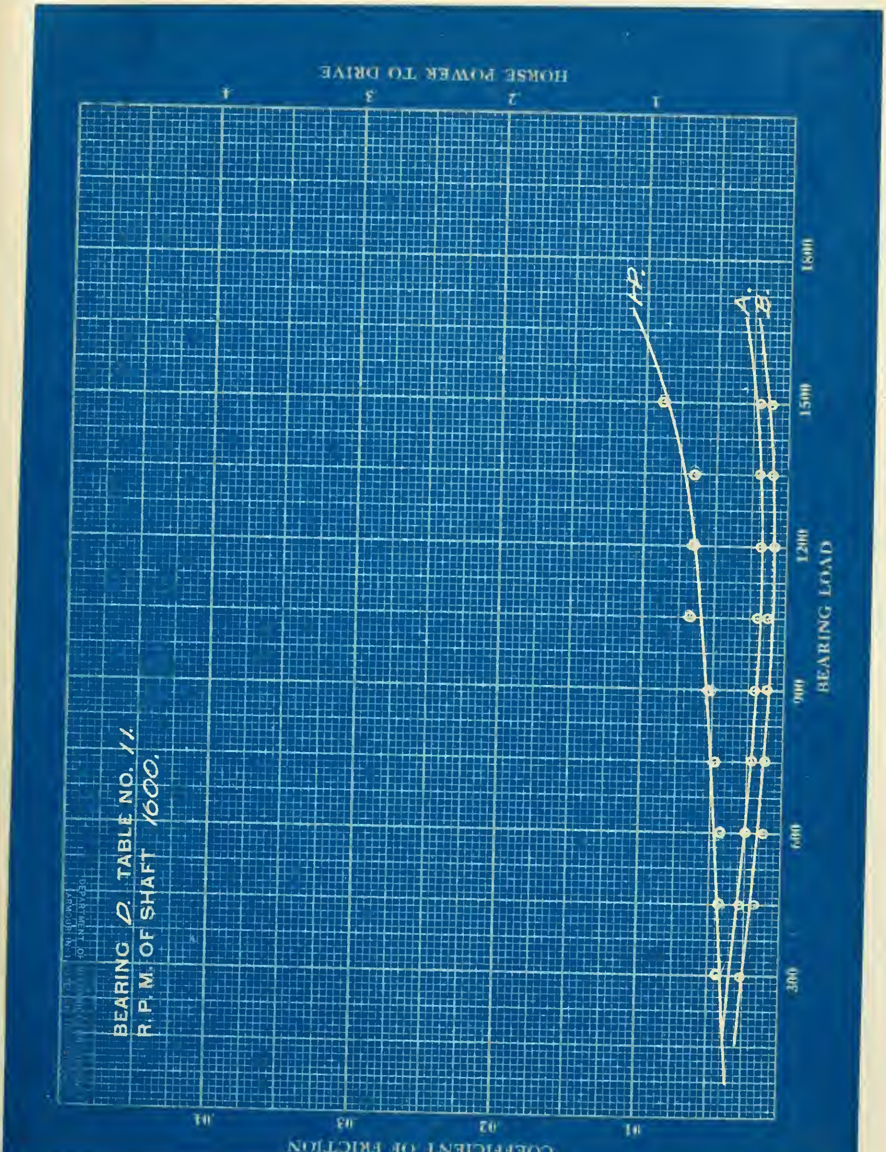

BEARING D TABLE NO. 7.
BEARING LOAD 600 LBS.
ROOM TEMP. 74° F.
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
H.P.
A.
B.

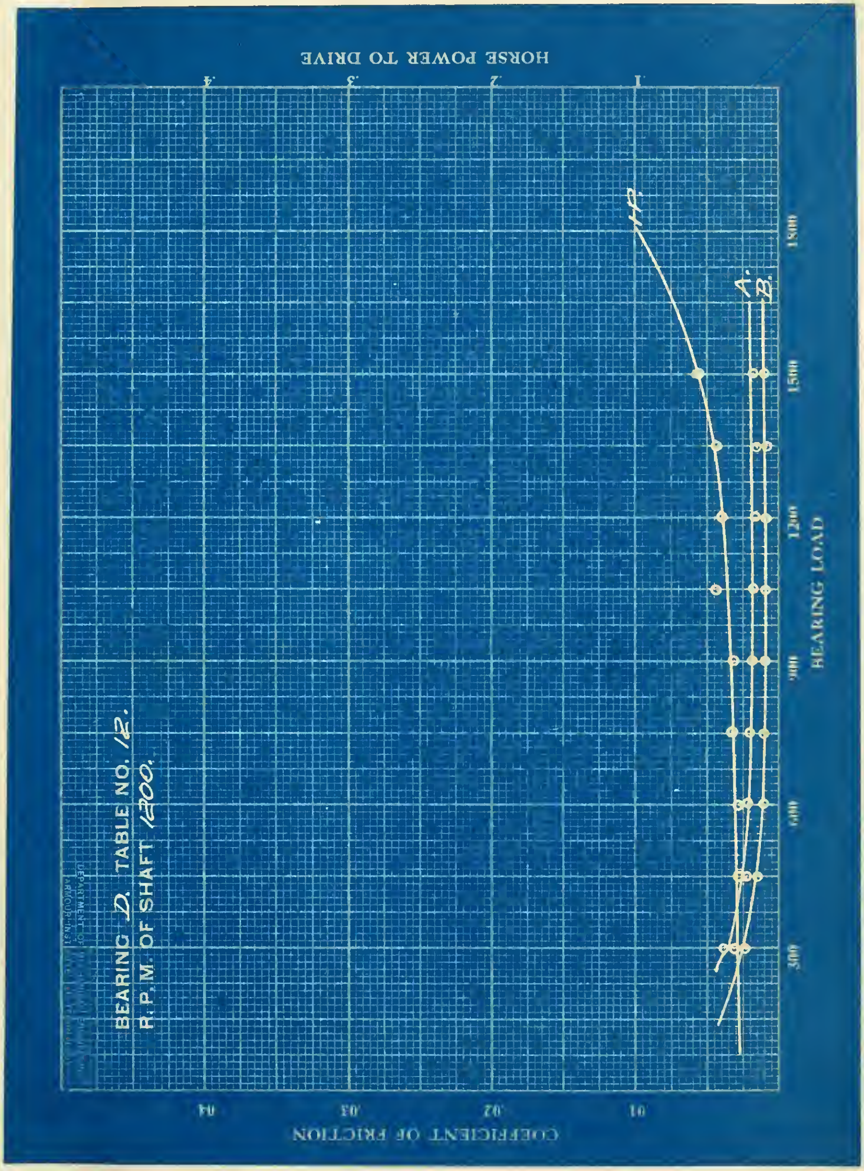

BEARING D TABLE NO. 8
BEARING LOAD 450 LBS.
ROOM TEMP. 74°F
HORSE POWER TO DRIVE
COEFFICIENT OF FRICTION
R. P. M OF SHAFT
HP
A
B

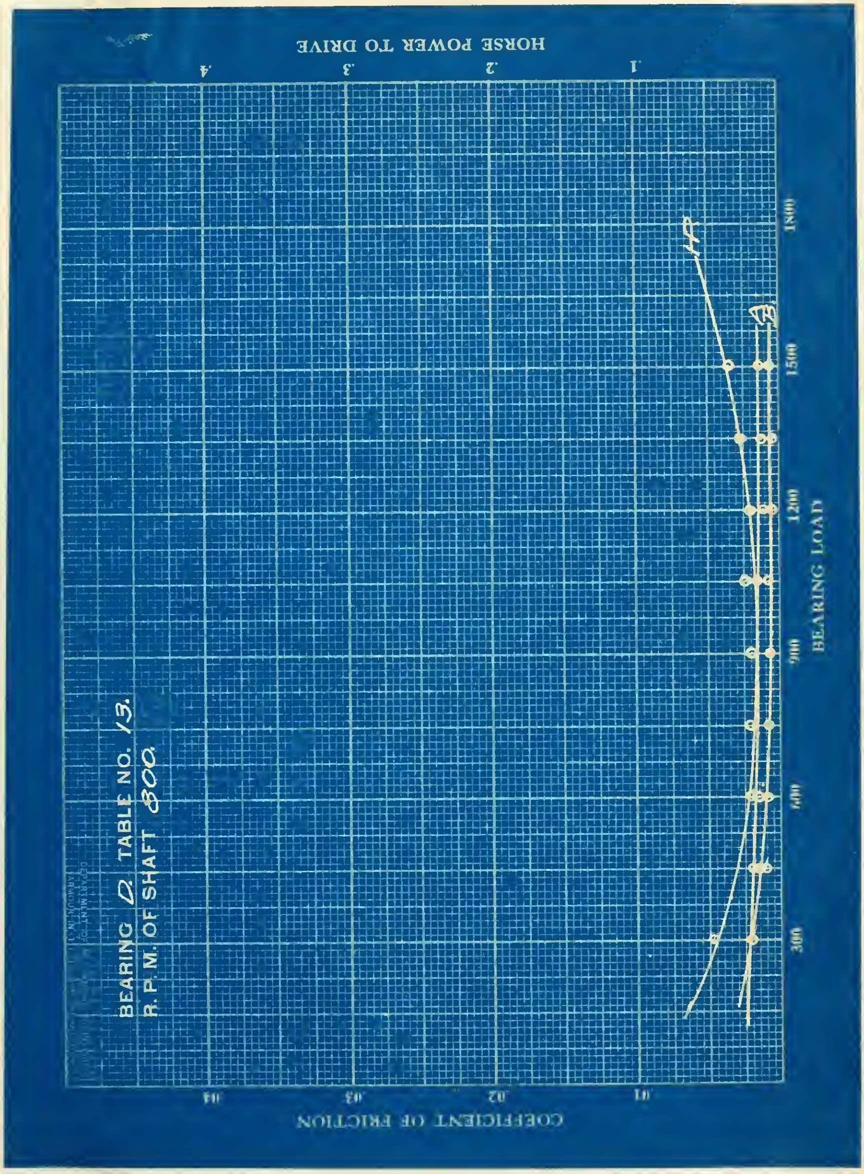


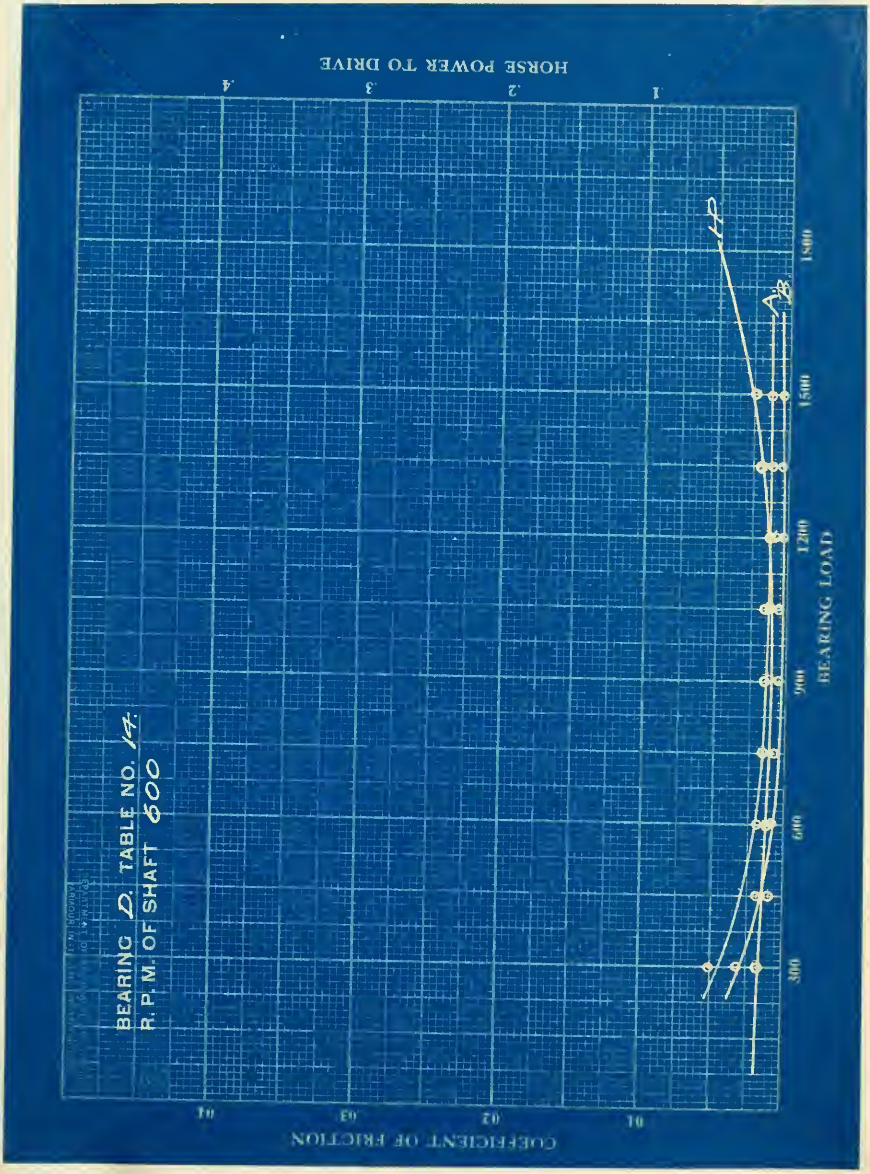
BEARING D TABLE NO. 9
BEARING LOAD 1500 LBS
ROOM TEMP. 74°F.
HORSE POWER TO DRIVE
1
2
3
4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R P M OF SHAFT
400
800
1200
1600
2000
2400

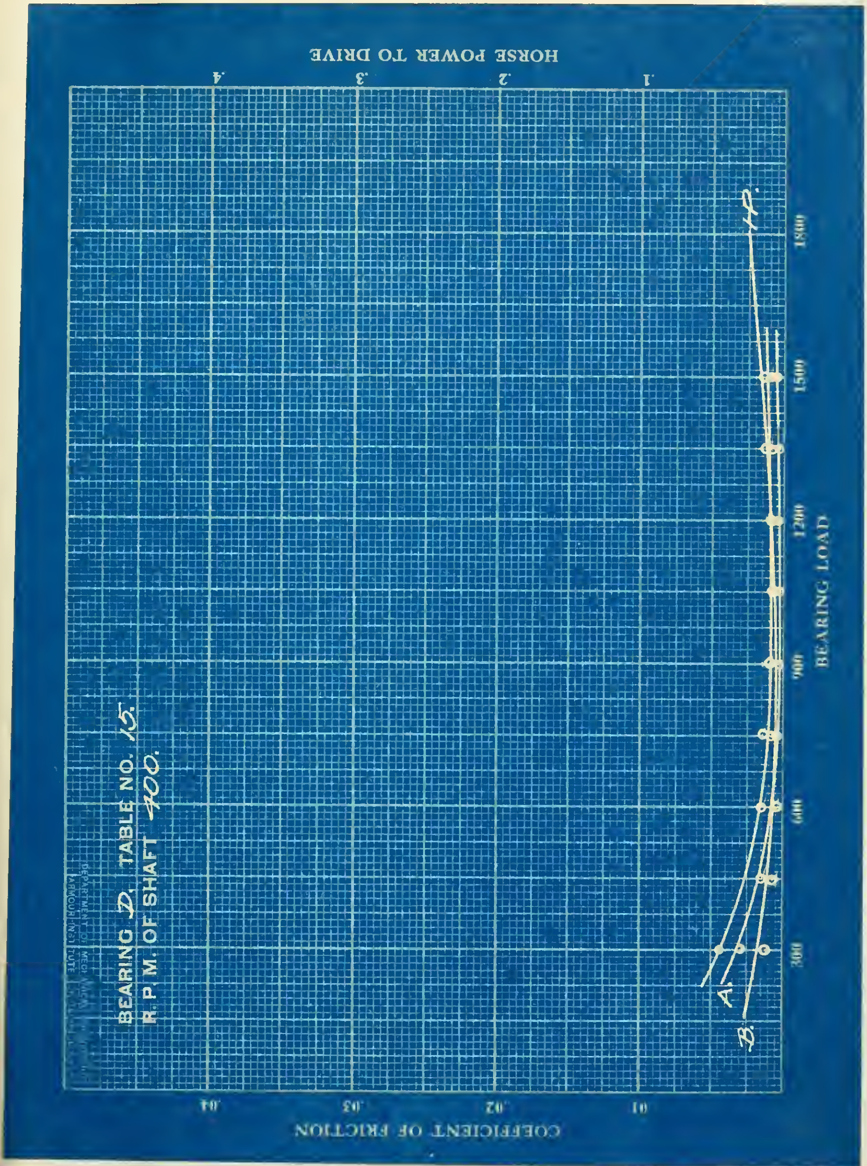

BEARING D. TABLE NO. 10.
R. P. M. OF SHAFT 2000.
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
BEARING LOAD
300
600
900
1200
1500
1800
HP
A
B

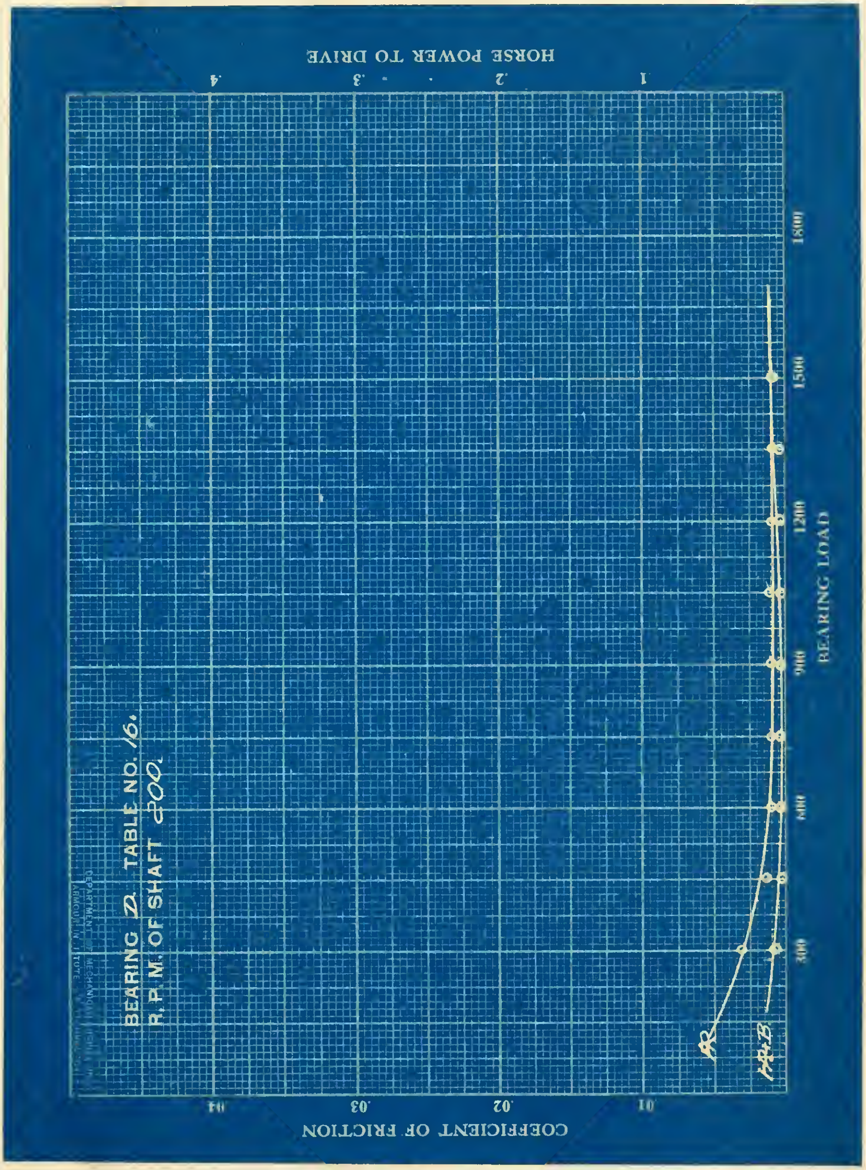

BEARING D. TABLE NO. 11.
R. P. M. OF SHAFT 1600.
HORSE POWER TO DRIVE
COEFFICIENT OF FRICTION
BEARING LOAD
H.P.
A.
B.


BEARING D. TABLE NO. 12.
R.P.M. OF SHAFT 1200.
HORSE POWER TO DRIVE
1
2
3
4
HP
A.
B.
BEARING LOAD
300
600
900
1200
1500
1800
COEFFICIENT OF FRICTION
.01
.02
.03
.04


BEARING D TABLE NO. 13.
R. P. M. OF SHAFT 800
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
BEARING LOAD
300
600
900
1200
1500
1800


BEARING D. TABLE NO. 14.
R. P. M. OF SHAFT 600
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
BEARING LOAD
300
600
900
1200
1500
1800
HP
A
B


BEARING D. TABLE NO. 15.
R. P. M. OF SHAFT 400.
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
BEARING LOAD
300
600
900
1200
1500
1800
A.
B.
H.P.
ARMOUR INSTITUTE


BEARING D. TABLE NO. 16.
R.P.M. OF SHAFT 200.
HORSE POWER TO DRIVE
.1
.2
.3
.4
BEARING LOAD
300
600
900
1200
1500
1800
COEFFICIENT OF FRICTION
.01
.02
.03
.04

BEARING "E"

Fig. 14

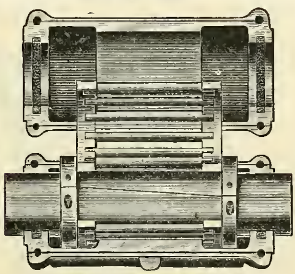


Fig. 15

BEARING"E"

Bearing "E", (Figures 14,15), is a roller bearing with a single roller structure, with all parts split so as to be able to apply the bearing to the shaft easily.

A split bushing or sleeve fits over the shaft and this is the raceway for the rolls. Two collars which clamp the split bushing to the shaft retain the roller structure, affording movable surfaces with which the ends of the roller structure come into contact. The collars do not touch the box, thereby, relieving the bearing from end thrust.

The rolls are held by a steel retainer and each retainer is split. A ground portion of the inside of the bearing box provides an outer raceway for the rolls. The grease is retained in the box by pieces of felt which fit into grooves in the ends of the bearing box.

The chief fault of this bearing is that when mounting the split bushing on the

shaft, it would never fit exactly around the circumference and consequently did not provide a perfectly cylindrical raceway for the rolls. The result of this, is, that there is a pounding up and down of the split retainer and an inability of the rolls to take their proper load. This caused a heating of the bearing and a comparatively high coefficient of friction.

During all runs, the felt oil retainers were removed as they were so tight against the shaft that they caused the bearing and shaft to heat up to a greater extent than was allowable, but, this fault could be easily overcome by the use of a better grade of felt and having a looser fit on the shaft.

While running under load, the bearing was quite noisy and prone to heat up to an alarming extent.

TABLES 1 - 13

OF

BEARING "E"

BEARING E

Table No. 1 Date July 21st, 1915.

Bearing Load, LBS. 1500 Time, beginning of run 8:58 A.M.

Room Temp.° Fahr. 73 Time, end of run

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.82	526	25.05	0.215	0.0137	0.01048
0.76	512	23.90	0.195	0.0131	0.0100
0.73	488	23.00	0.178	0.0126	0.00962
0.67	476	21.10	0.159	0.0116	0.00886
0.645	429	20.30	0.138	0.0111	0.00848
0.61	310	19.20	0.095	0.0105	0.00802
0.58	228	18.25	0.066	0.0100	0.00763

Remarks:— Considerable vibration noted during run.

[illegible]

[illegible]

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[illegible]

BEARING E

Table No. 2 Date July 21st, 1915.

Bearing Load, LBS. 1350 Time, beginning of run

Room Temp.° Fahr. 73 Time, end of run

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.73	564	23.30	0.208	0.0142	0.01083
0.68	551	21.40	0.188	0.0131	0.0100
0.67	528	21.10	0.177	0.0128	0.00977
0.57	469	17.95	0.132	0.0109	0.00832
0.495	442	15.60	0.110	0.0095	0.00725
0.48	319	15.10	0.077	0.0092	0.00703
0.47	237	14.80	0.056	0.0090	0.00688

Remarks:—

BEARING E

Table No. 3 Date July 21st, 1915.

Bearing Load, LBS. 1200 Time, beginning of run

Room Temp.° Fahr. 73 Time, end of run 9:33 A.M.

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.69	618	21.70	0.213	0.0148	0.01130
0.575	602	18.10	0.173	0.0124	0.00947
0.48	536	15.10	0.129	0.0104	0.00794
0.445	433	14.00	0.096	0.0096	0.00733
0.425	401	13.40	0.085	0.0092	0.00703
0.42	364	13.21	0.077	0.0091	0.00695
0.43	284	13.52	0.061	0.0093	0.00710
0.445	258	14.00	0.058	0.0096	0.00733
0.46	200	14.48	0.046	0.0099	0.00755

Remarks:—

BEARING E

Table No. 4 Date July 21st, 1915.

Bearing Load, LBS. 1050 Time, beginning of run 9:35 A.M.

Room Temp.° Fahr. 73 Time, end of run

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
0.56	626	17.62	0.175	0.0138	0.01053
0.49	607	15.42	0.149	0.0121	0.00925
0.43	570	13.53	0.123	0.0106	0.00809
0.415	461	13.08	0.096	0.0102	0.00779
0.39	425	12.28	0.083	0.0096	0.00733
0.36	383	11.34	0.069	0.0089	0.00679
0.375	316	11.80	0.059	0.0092	0.00703
0.37	311	11.64	0.057	0.0091	0.00695
0.385	258	12.12	0.050	0.0095	0.00725
0.405	180	12.73	0.036	0.0100	0.00754

Remarks:—

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

BEARING E

Table No. 5 Date July 21st, 1915.

Bearing Load, LBS. 900 Time, beginning of run

Room Temp.° Fahr. 73 Time, end of run

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.345	627	10.86	0.108	0.0099	0.00756
0.33	542	10.38	0.090	0.0095	0.00725
0.31	502	9.77	0.078	0.0089	0.00679
0.305	424	9.60	0.065	0.0086	0.00657
0.31	414	9.77	0.064	0.0089	0.00679
0.315	331	9.92	0.052	0.0091	0.00695
0.32	297	10.08	0.048	0.0092	0.00903
0.34	210	10.38	0.035	0.0095	0.00725

Remarks:—

BEARING E

Table No. 6 Date July 21st, 1915.

Bearing Load, LBS. 750 Time, beginning of run 10 A.M.

Room Temp.° Fahr. 73 Time, end of run

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.315	670	9.92	0.106	0.0109	0.00833
0.295	621	9.28	0.092	0.0102	0.00778
0.275	538	8.67	0.094	0.0095	0.00725
0.27	495	8.50	0.067	0.0093	0.00710
0.26	385	8/18	0.050	0.0090	0.00687
0.265	365	8.34	0.048	0.0091	0.00695
0.27	304	8.50	0.041	0.0093	0.00710
0.275	288	8.66	0.040	0.0095	0.00625
0.28	212	8.82	0.030	0.0097	0.00741

Remarks:—

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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BEARING E

Table No. 7 Date July 21st, 1915.

Bearing Load, LBS. 600 Time, beginning of run

Room Temp.° Fahr. 73 Time, end of run

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	COEFFICIENT OF FRICTION Bearing
0.265	645	8.34	0.086	0.0114	0.0087
0.26	596	8.18	0.078	0.0112	0.0086
0.24	525	7.57	0.063	0.0103	0.00786
0.23	441	7.25	0.051	0.0099	0.00756
0.22	388	6.94	0.043	0.0095	0.00725
0.21	292	6.63	0.031	0.0091	0.00695
0.215	266	6.78	0.029	0.0093	0.00710
0.23	177	7.25	0.020	0.0099	0.00756

Remarks:—

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

BEARING E

Table No. 8 Date July 21st, 1915.

Bearing Load, LBS. 450 Time, beginning of run

Room Temp.° Fahr. 73 Time, end of run

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.215	659	6.78	0.071	0.0124	0.00946
0.205	558	6.48	0.057	0.0118	0.00901
0.195	476	6.15	0.046	0.0113	0.00862
0.19	445	5.99	0.042	0.0109	0.00832
0.18	365	5.68	0.033	0.0104	0.00794
0.17	320	5.36	0.027	0.0098	0.00748
0.16	260	5.04	0.021	0.0092	0.00703
0.17	189	5.36	0.016	0.0098	0.00748
0.175	149	5.52	0.013	0.0101	0.00771

Remarks:—

BEARING E

Table No. 9 Date July 21st, 1915.

Bearing Load, LBS. 300 Time, beginning of run

Room Temp.° Fahr. 73 Time, end of run

Observers

NOTE:—All data average of four bearings.

POUNDS at 31½ in. radius	R. P. M.	TORQUE Inch Lbs.	Horse Power to Drive	COEFFICIENT OF FRICTION	
				Shaft	Bearing
0.20	671	6.31	0.067	0.0173	0.01320
0.19	632	5.98	0.060	0.0164	0.01251
0.18	591	5.68	0.053	0.0155	0.01182
0.165	529	5.20	0.044	0.0142	0.01083
0.155	411	4.88	0.032	0.0134	0.01023
0.145	377	4.57	0.027	0.0125	0.00953
0.14	318	4.42	0.022	0.0121	0.00923
0.13	247	4.10	0.016	0.0112	0.00855
0.13	202	4.10	0.013	0.0112	0.00855
0.14	128	4.26	0.009	0.0117	0.00893
0.145	66	4.41	0.005	0.0121	0.00923

Remarks:—

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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DATA INTERPOLATED
FROM TABLES 1—9

Bearing E

R. P. M. of Shaft 600

Table No. 10

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
1500		0.016	0.014
1350	0.245	0.016	0.014
1200	0.2	0.014	0.0105
1050	0.14	0.0125	0.0096
900	0.10	0.0095	0.0075
750	0.09	0.0101	0.008
600	0.077	0.0103	0.0082
450	0.057	0.0157	0.012
300	0.063	0.0137	0.0092

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing E

R. P. M. of Shaft 400

Table No. 11

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION Shaft	Bearing
1500	0.12	0.0107	0.008
1350	0.105	0.0098	0.0075
1200	0.088	0.0095	0.0072
1050	0.075	0.0092	0.0070
900	0.058	0.0088	0.0068
750	0.052	0.0095	0.0072
600	0.05	0.0095	0.0077
450	0.03	0.0127	0.0096
300	0.04	0.0105	0.008

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing E

R. P. M. of Shaft 200

Table No. 12

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.06	0.01	0.0079
1350	0.05	0.009	0.007
1200	0.045	0.0095	0.0075
1050	0.04	0.0097	0.0075
900	0.033	0.0095	0.0075
750	0.03	0.0098	0.0075
600	0.025	0.0097	0.008
450	0.01	0.0115	0.0088
300	0.016	0.0098	0.0074

Remarks:—

DATA INTERPOLATED
FROM TABLES 1—9

Bearing E

R. P. M. of Shaft 100

Table No. 13

Bearing Load	Horse Power to Drive	COEFFICIENT OF FRICTION	
		Shaft	Bearing
1500	0.046	0.0105	0.0085
1350	0.036	0.0095	0.0076
1200	0.035	0.0106	0.0089
1050	0.023	0.011	0.0085
900	0.026	0.011	0.0089
750	0.025	0.0105	0.0082
600	0.01	0.0102	0.0085
450	0.005	0.012	0.009
300	0.007	0.0097	0.0073

Remarks:—

CURVES PLOTTED FROM

TABLES 1 - 13

OF

BEARING "E"

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[illegible]

[illegible]

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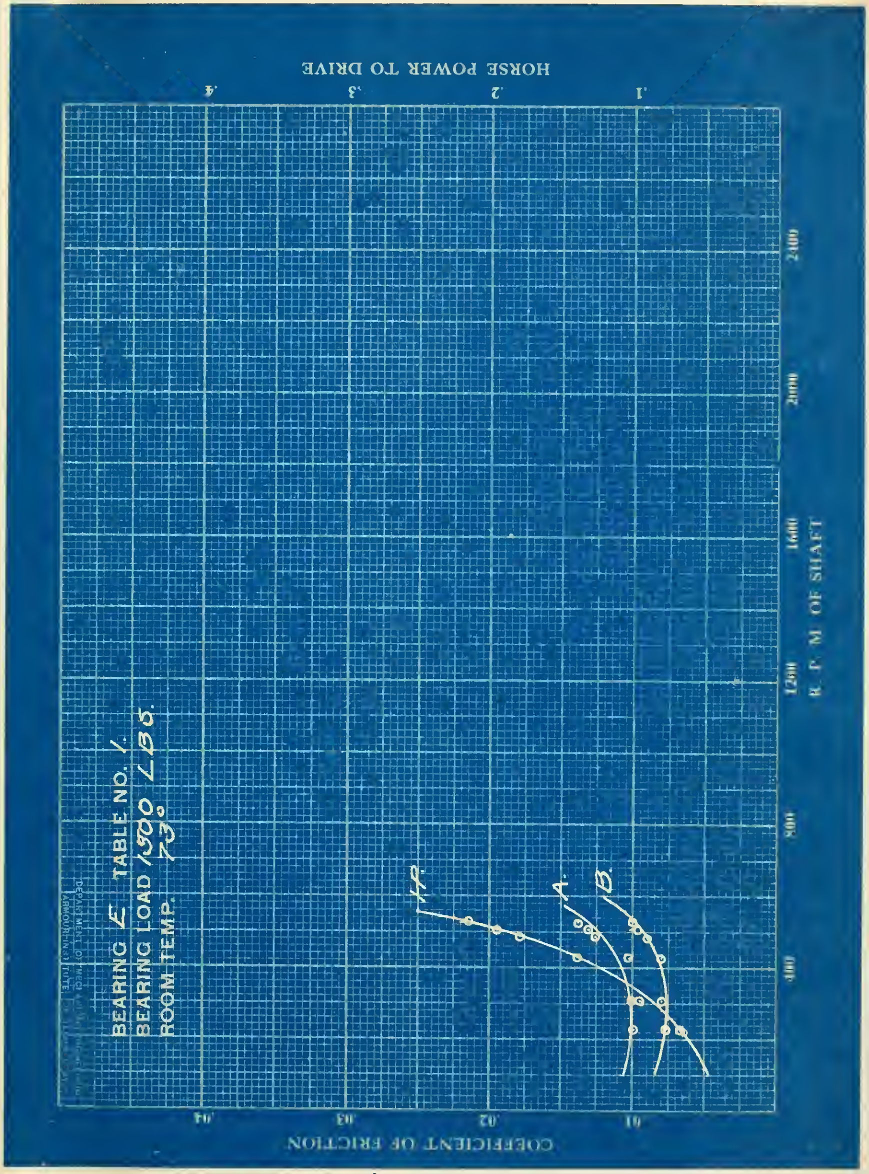
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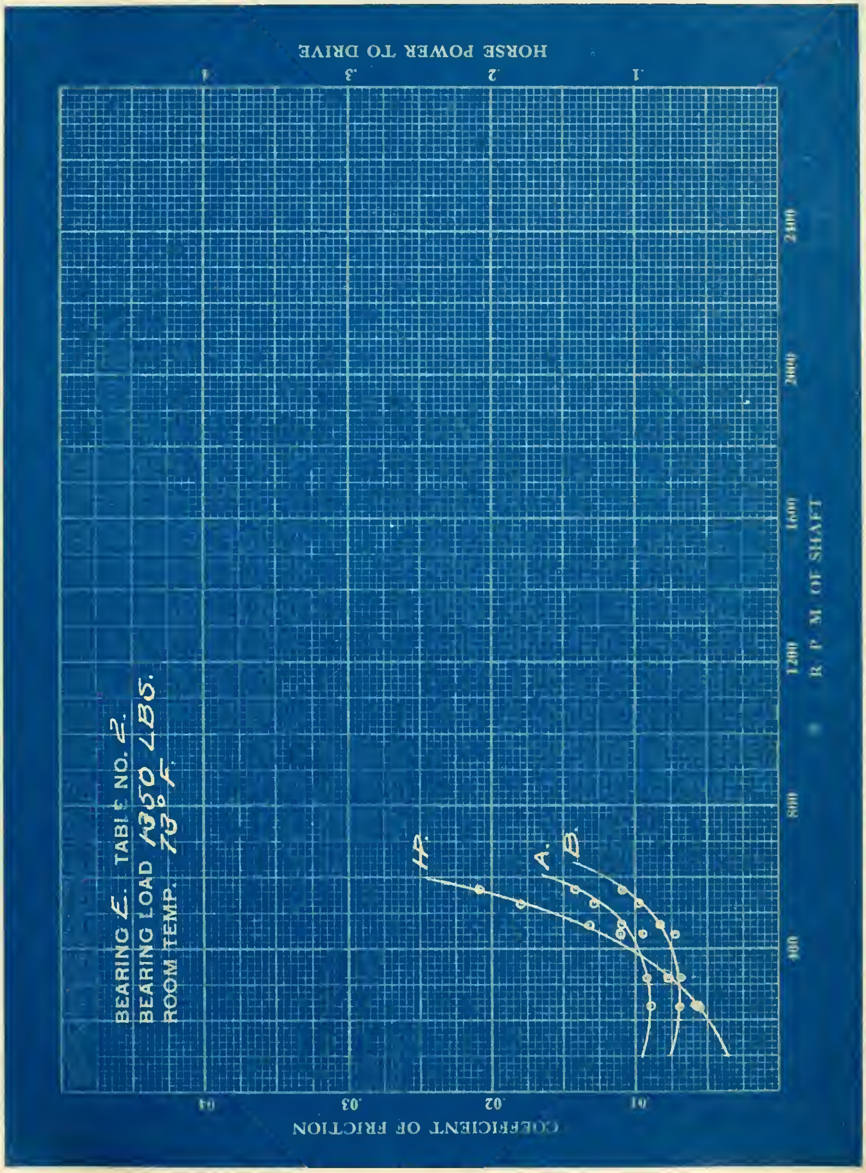
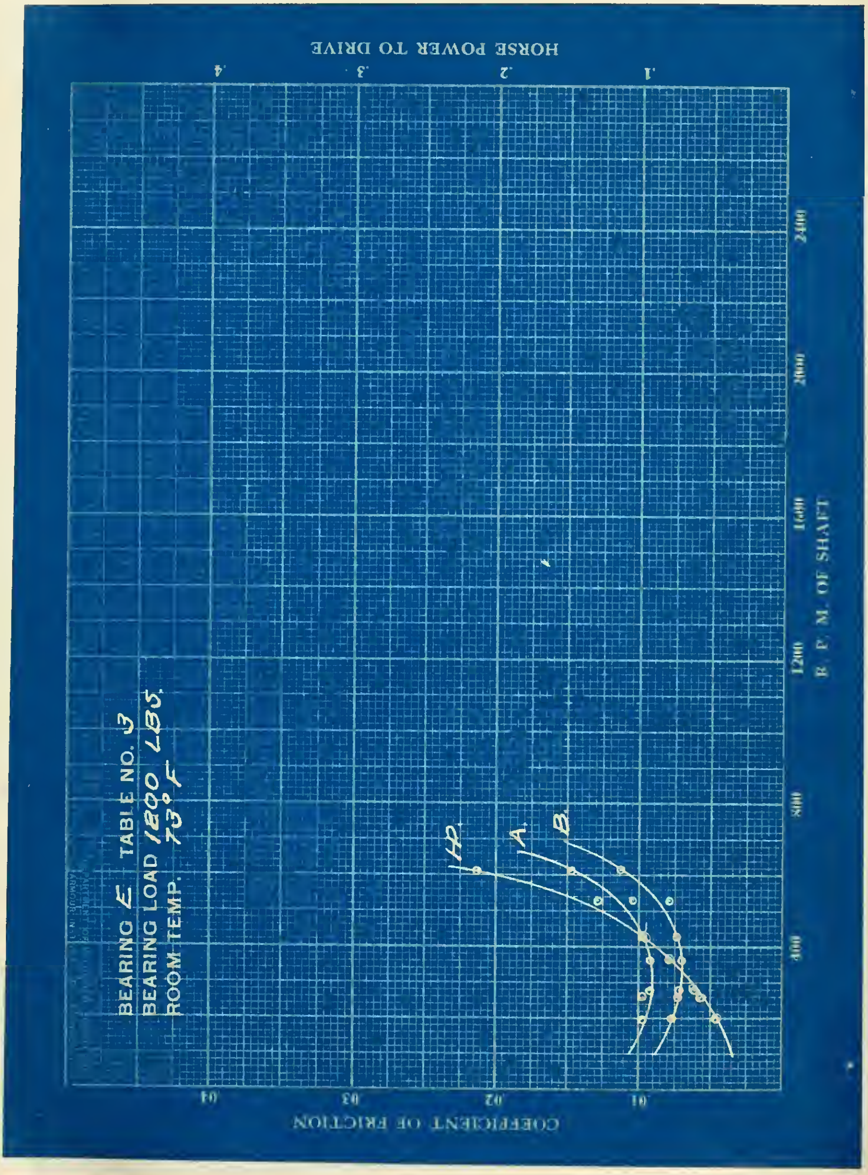
BEARING LOAD 1500 LBS.
ROOM TEMP. 73°
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
H.P.
A.
B.



BEARING E. TABLE NO. 2.
BEARING LOAD 1350 LBS.
ROOM TEMP. 73° F.
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R P M OF SHAFT
400
800
1200
1600
2000
2400
H.P.
A.
B.



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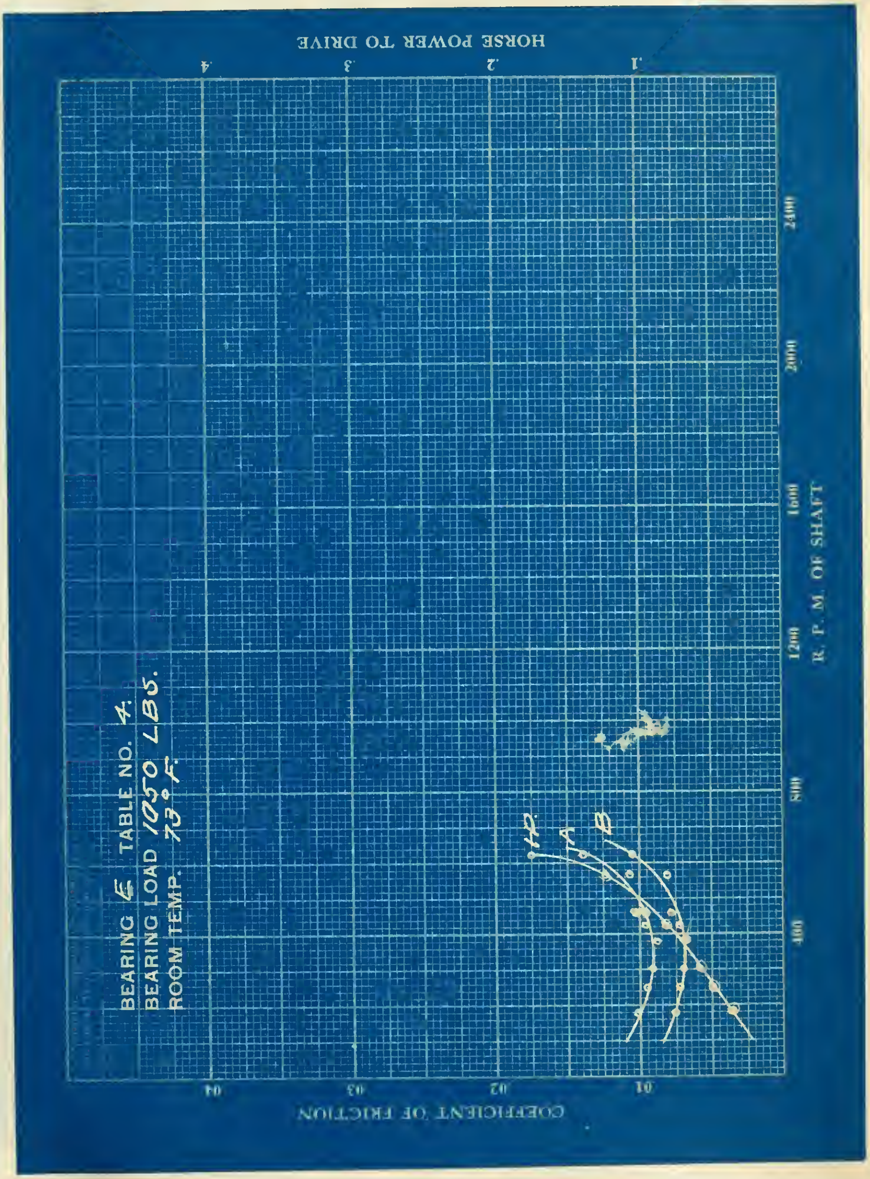
BEARING LOAD 1800 LBS.
ROOM TEMP. 73° F
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
H.P.
A.
B.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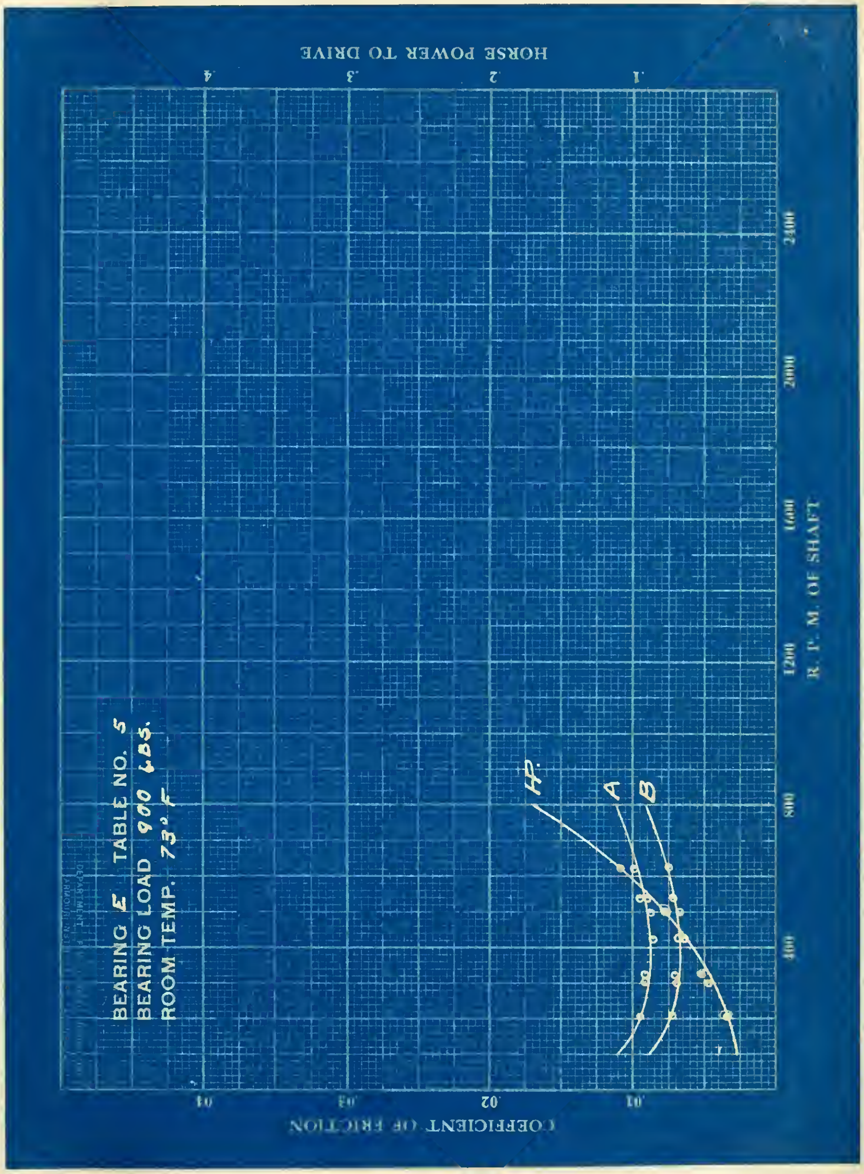
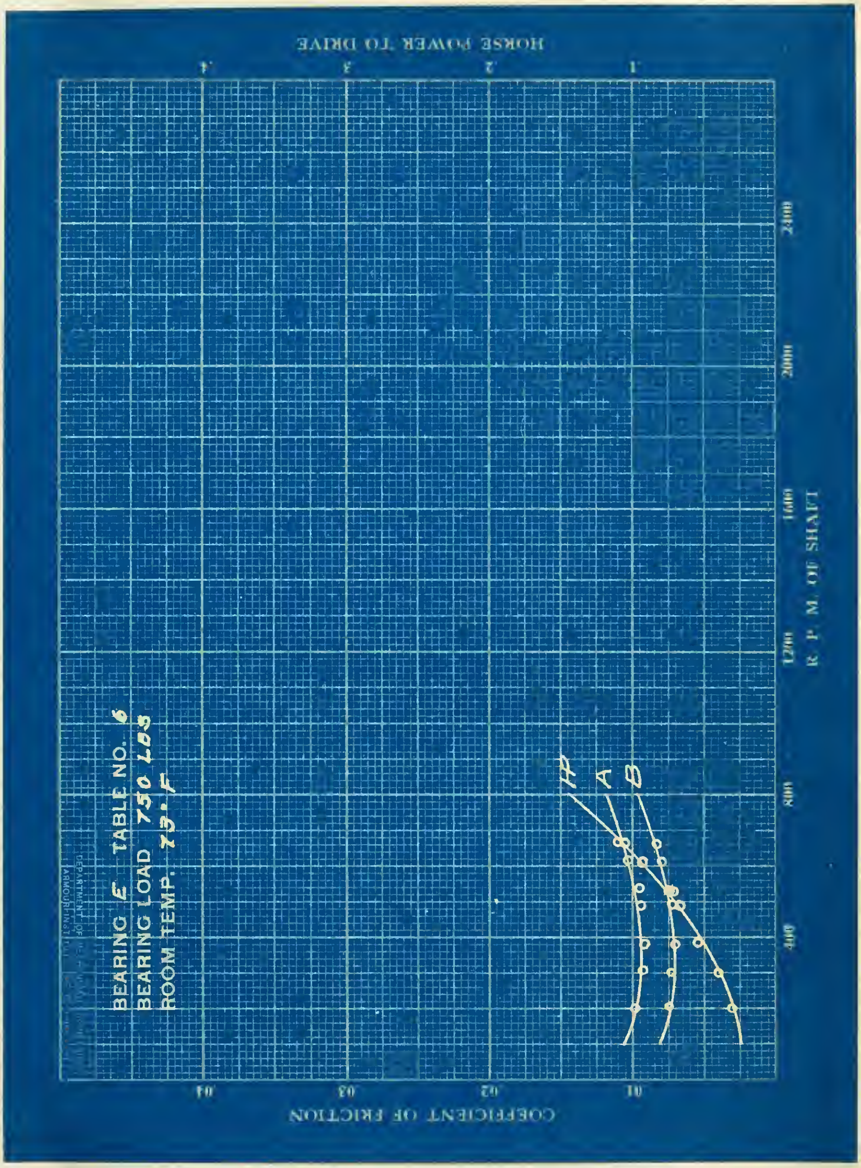
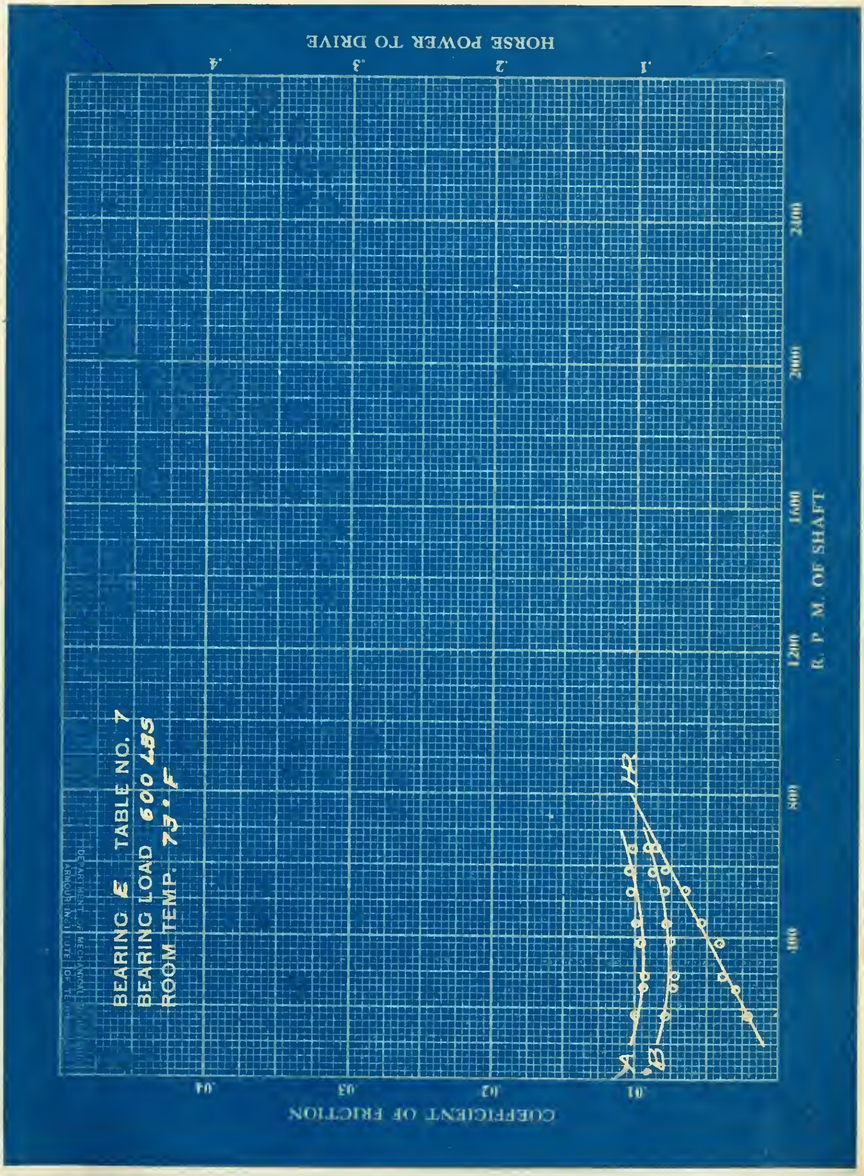
BEARING LOAD 1050 LBS.
ROOM TEMP. 73° F.
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
H.P.
A
B


BEARING E TABLE NO. 5
BEARING LOAD 900 LBS.
ROOM TEMP. 73° F
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
H.P.
A
B


HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
BEARING E TABLE NO. 6
BEARING LOAD 750 LBS
ROOM TEMP. 73° F
HP
A
B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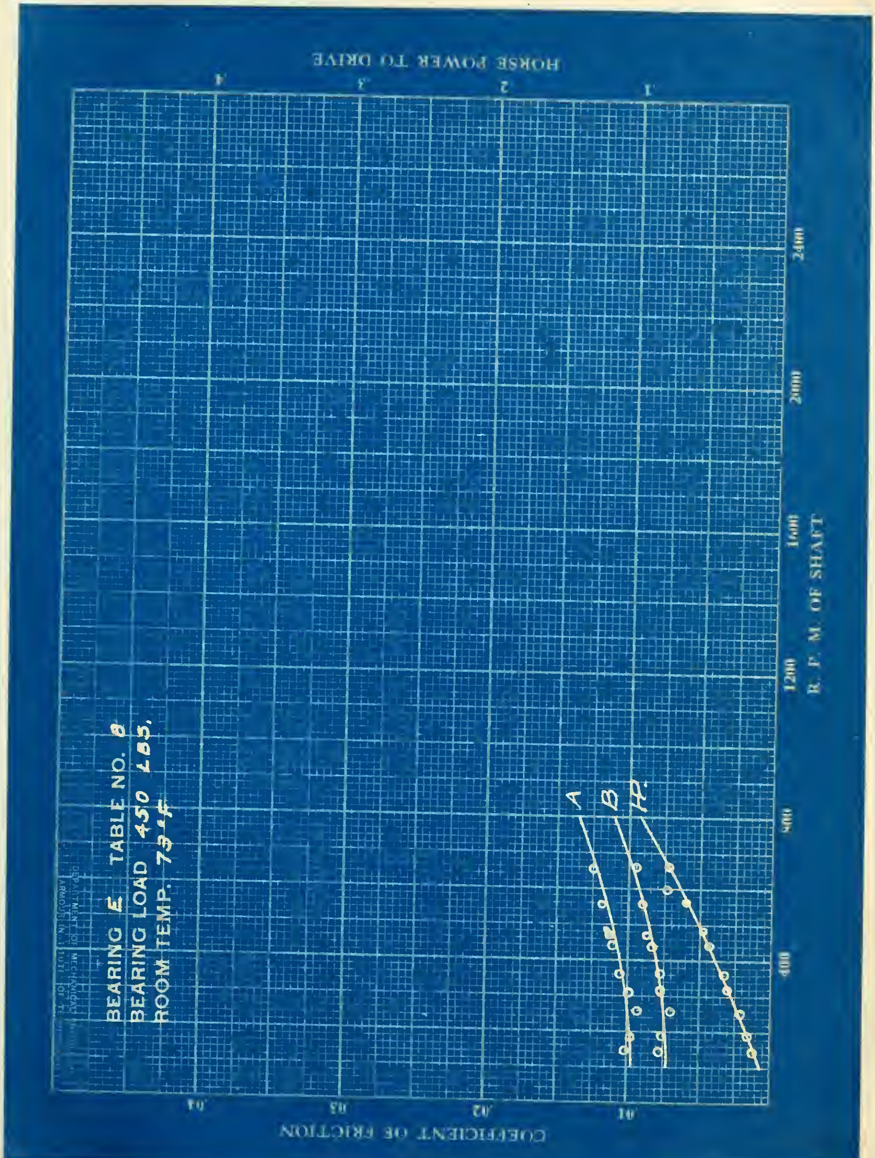
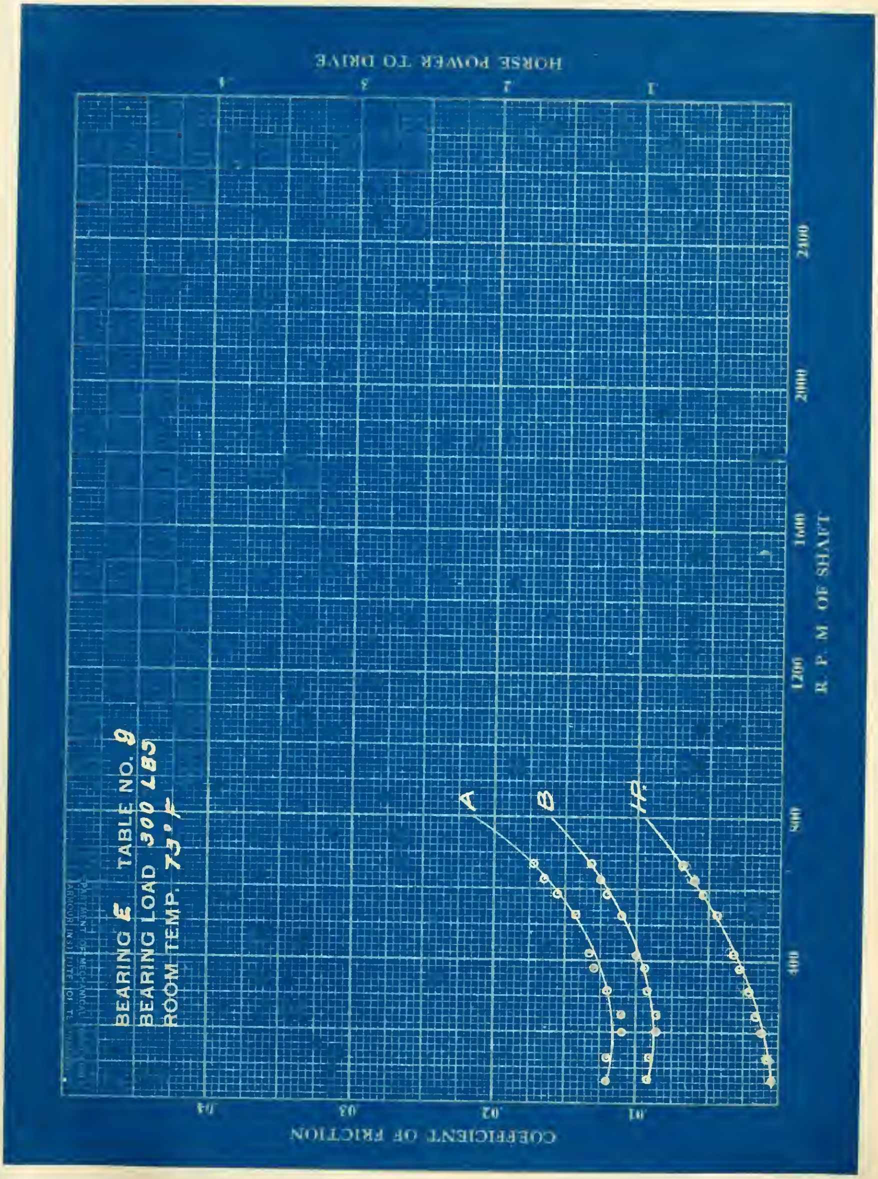
BEARING LOAD 600 LBS
ROOM TEMP. 73° F
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
HP
A
B


BEARING E TABLE NO. 8
BEARING LOAD 450 LBS.
ROOM TEMP. 73°F
A
B
H.P.
HORSE POWER TO DRIVE
1
2
3
4
R. P. M. OF SHAFT
400
800
1200
1600
2000
2400
COEFFICIENT OF FRICTION
.01
.02
.03
.04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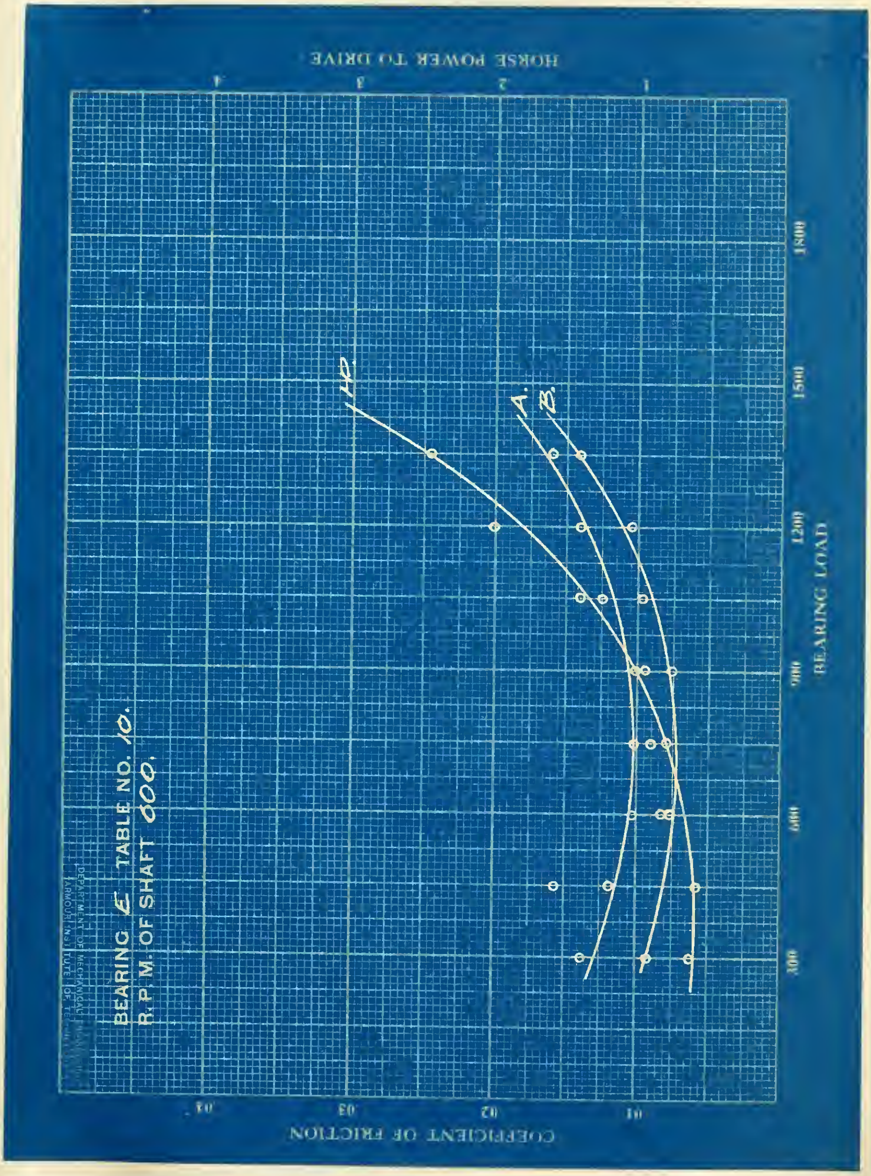
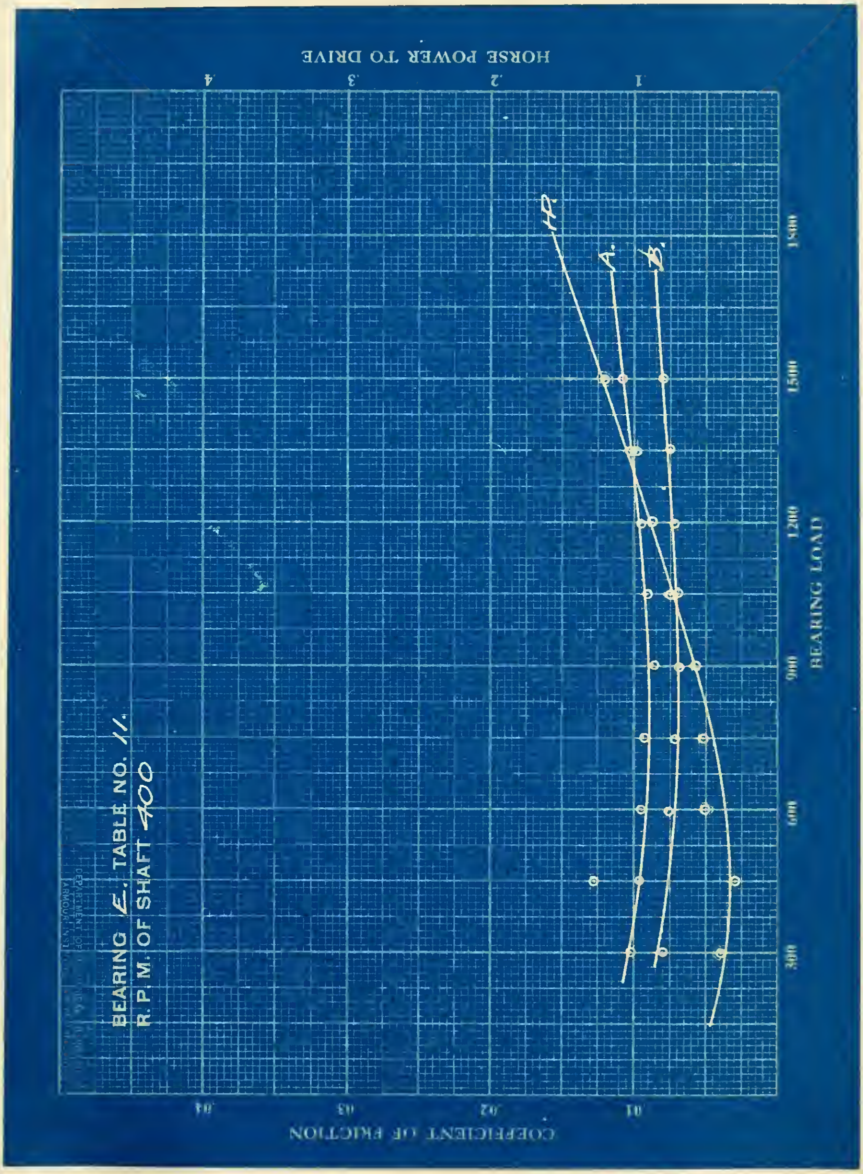
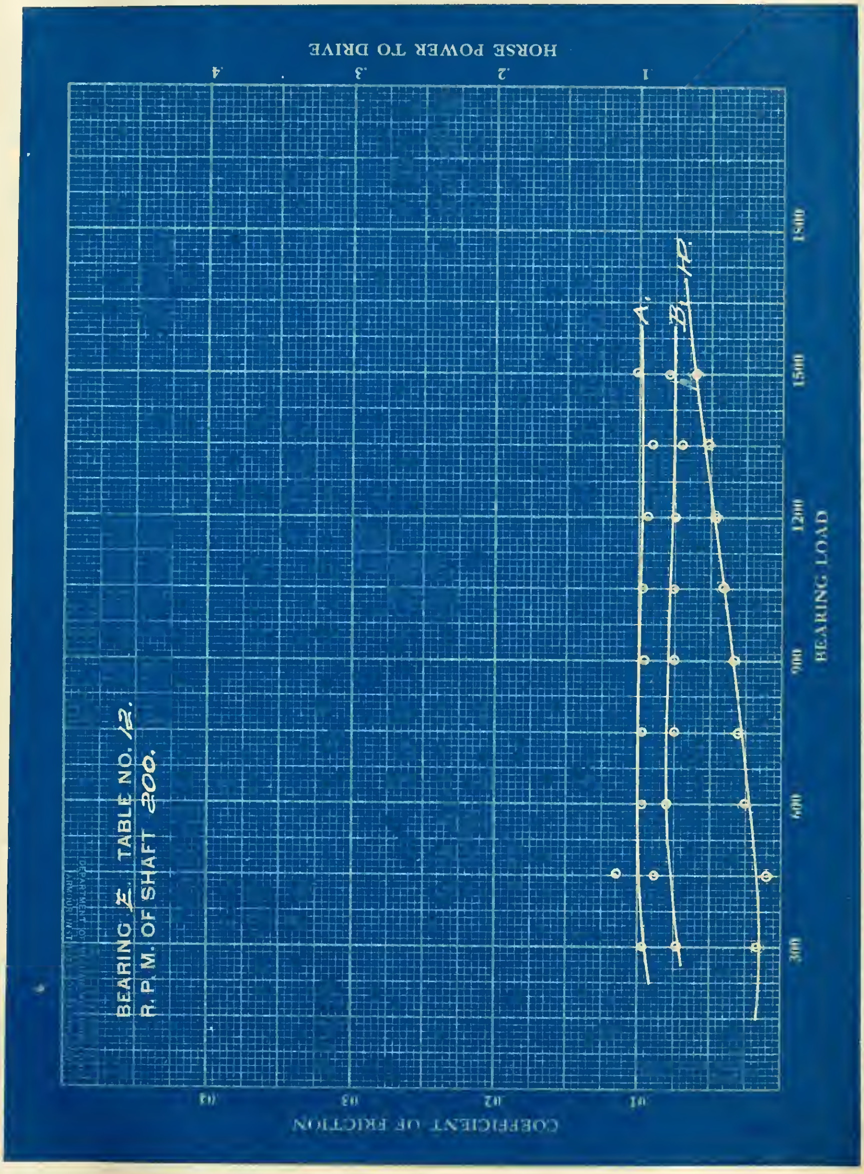
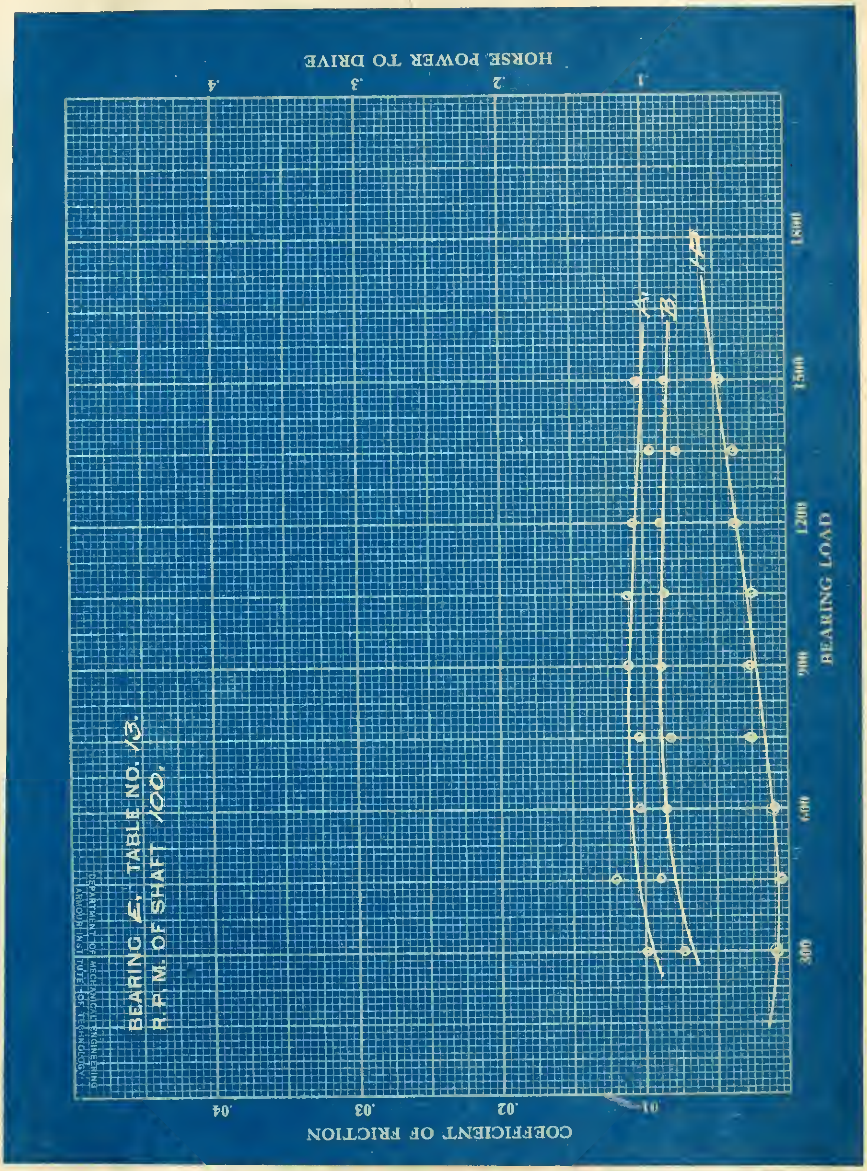
BEARING LOAD 300 LBS
ROOM TEMP. 73°F
HORSE POWER TO DRIVE
COEFFICIENT OF FRICTION
R. P. M. OF SHAFT
A
B
HP.



BEARING E TABLE NO. 10.
R.P.M. OF SHAFT 600.
HORSE POWER TO DRIVE
COEFFICIENT OF FRICTION
BEARING LOAD
HP.
A.
B.


BEARING E. TABLE NO. 11.
R.P.M. OF SHAFT 400
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
BEARING LOAD
300
600
900
1200
1500
1800
HP.
A.
B.


BEARING E. TABLE NO. 12.
R. P. M. OF SHAFT 200.
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
BEARING LOAD
300
600
900
1200
1500
1800
A.
B.
H.P.


BEARING E. TABLE NO. 13.
R.P.M. OF SHAFT 100.
DEPARTMENT OF MECHANICAL ENGINEERING
ARMOUR INSTITUTE OF TECHNOLOGY
HORSE POWER TO DRIVE
.1
.2
.3
.4
COEFFICIENT OF FRICTION
.01
.02
.03
.04
BEARING LOAD
300
600
900
1200
1500
1800
A'
B.
A

- -

MAXIMUM AND MINIMUM

CURVES FOR

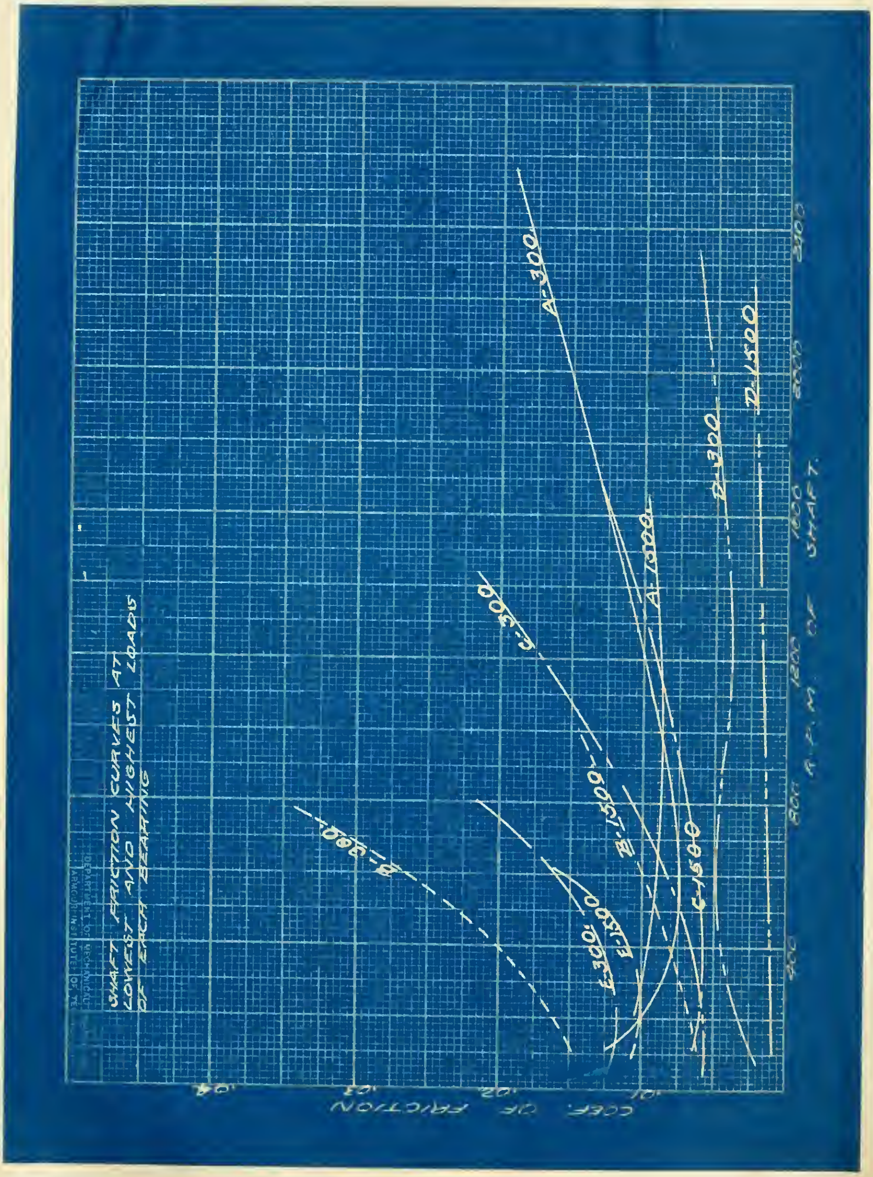
ALL BEARINGS

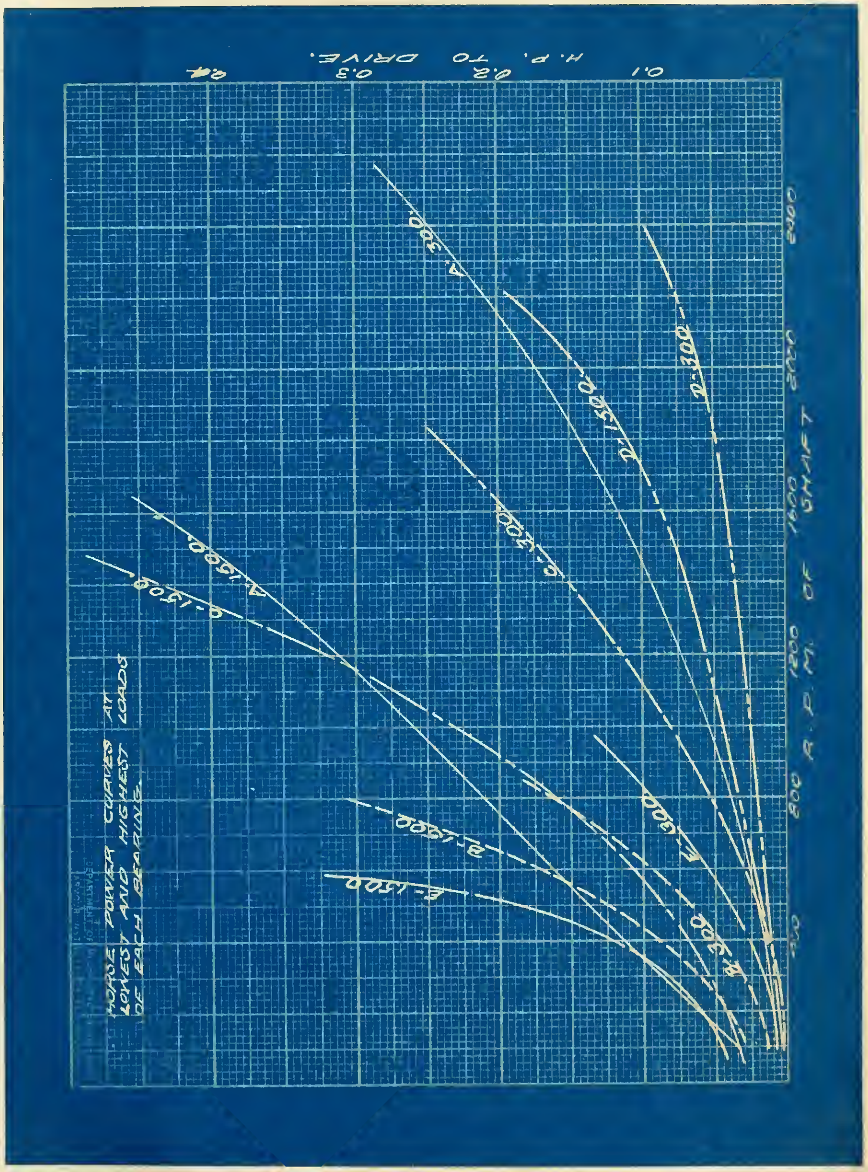
- -

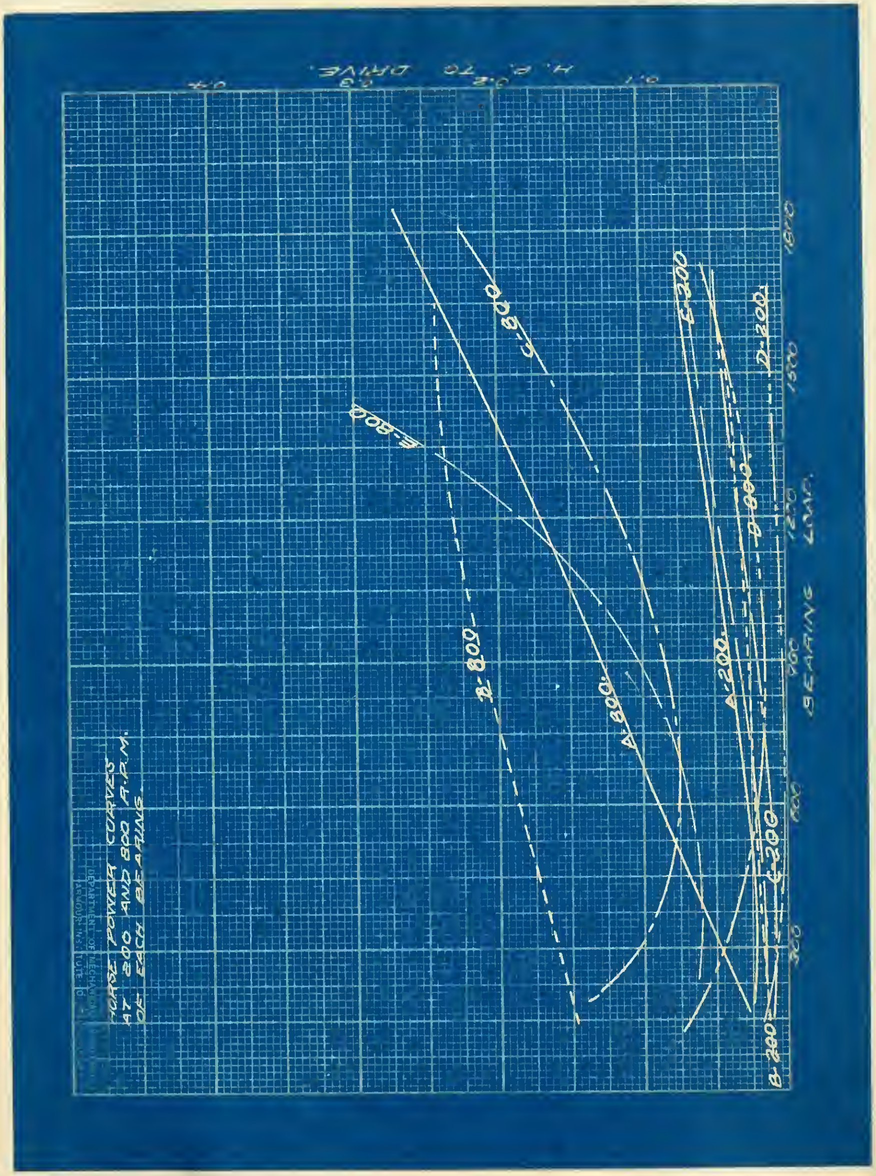
[illegible]

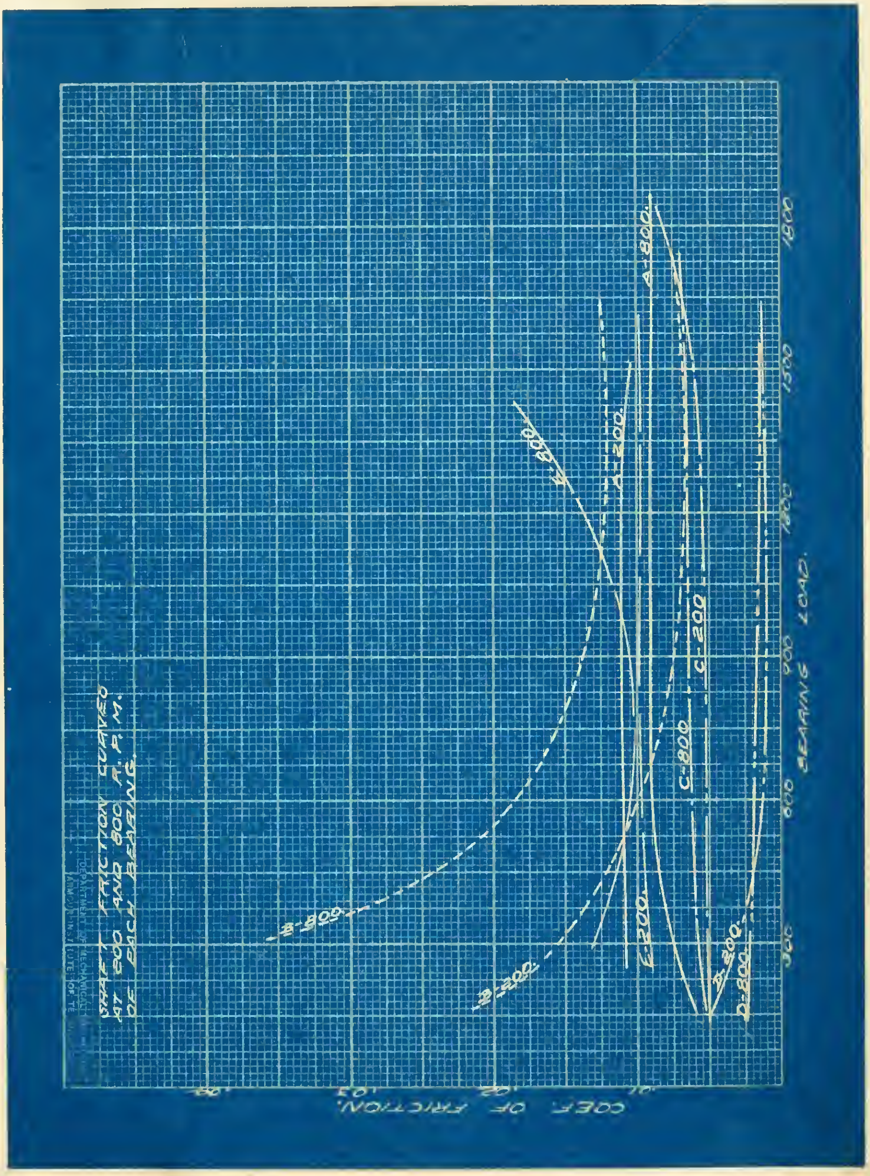
[illegible]

[illegible]


SHAFT FRICTION CURVES AT LOWEST AND HIGHEST LOADS OF EACH BEARING
COEF. OF FRICTION
.01
.02
.03
.04
R.P.M. OF SHAFT
400
800
1200
1600
A-300
A-1500
B-300
B-1500
C-300
C-1500
D-300
D-1500
E-300
E-1500


HORSE POWER CURVES AT LOWEST AND HIGHEST LOADS OF EACH BEARING.
H. P. TO DRIVE.
0.1
0.2
0.3
0.4
R. P. M. OF SHAFT
800
1200
1600
2000
A-300
A-1500
B-300
B-1500
C-300
C-1500
D-300
D-1500
E-300
E-1500


HORSE POWER CURVES
AT 200 AND 800 R.P.M.
OF EACH BEARING.
H. P. TO DRIVE
0.1
0.2
0.3
0.4
BEARING LOAD
300
600
900
1200
1500
1800
A-800
B-800
C-800
D-800
E-800
A-200
B-200
C-200
D-200
E-200


SHAFT FRICTION CURVES
AT 200 AND 800 R.P.M.
OF EACH BEARING.
COEF. OF FRICTION.
BEARING LOAD.
.03
.02
.01
300
600
900
1200
1500
1800
A-800
A-200
B-800
B-200
C-800
C-200
D-800
D-200
E-800
E-200

DISCUSSION OF RESULTS

DISCUSSION OF RESULTS

The first set of curves, plotted from tables 1 to 9, are those whose values are taken directly from the results of the test. Each sheet shows the curves for coefficients of friction and horse power to drive as compared to the speed of the shaft at some particular load.

The second set of curves, tables 10 to 16, were interpolated from the first set. The speed on each sheet being constant and the points plotted against a varying bearing load.

The third set is a résumé of the first set showing the maximum and minimum curves of the first set for each bearing.

The fourth set is a résumé of the second set, showing maximum and minimum curves for each bearing.

In all cases each curve is plainly marked with the bearing initial.

It will be seen from the sheet showing the maximum and minimum curves for each

Bearing plotted against the speed of the shaft that in every case, the coefficient of friction decreases as the load increases and that the coefficient of friction increases as the speed increases.

This sheet shows that Bearing "D", the ball bearing has the lower coefficient of friction at any load and speed than any other bearing. It further shows that the coefficient does not vary much with differences in load, and that it varies very little with any increase in speed, thus, giving to it all the desirable features of a shating bearing.

Bearing "C", the babbitt bearing showed itself to be next best at the low speeds, but, as soon as the speeds increased beyond five or six hundred R.P.M., Bearing "A", the duplex roller bearing showed itself to be better. Bearing "A" was very nearly as good as the babbitt at low speeds and very much better at high speeds, it being the only bearing which we could run at much more than 2000 R.P.M. It showed itself to be similar to the ball bearing because its curve was flat at all

loads and speeds. So for this reason, we should say that it was the second best bearing we tested.

At the low loads and low speeds, Bearing "B", the spiral roller bearing, showed itself to be the poorest of all, and at high speeds it had a tendency to increase its coefficient of friction to infinity.

Bearing "E", the third roller bearing was fairly good at low speeds, but, poor at high speeds. It did not vary to any great extent for the difference in load, but, as a whole the coefficient of friction was far too high.

Bearing "D" also showed its superiority by virtue of the fact that it took less power to drive it at any speed and load than any other bearing.

Bearings "A", "B", "C" and "E" showed themselves to take about the same power to drive at low speeds, although, Bearing "A" may be given the preference since it requires less power at the low speeds than the others.

At the high speeds and high loads, Bearing "A" also showed up well, although, very little better than the babbitt.

Bearing "B" and "E" showed up well on the low speeds only, but, an increased speed caused their friction to increase rapidly.

All the curves showed that the horse power necessary to drive increased with the load and increased with the speed.

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Arthur J. Aiter

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